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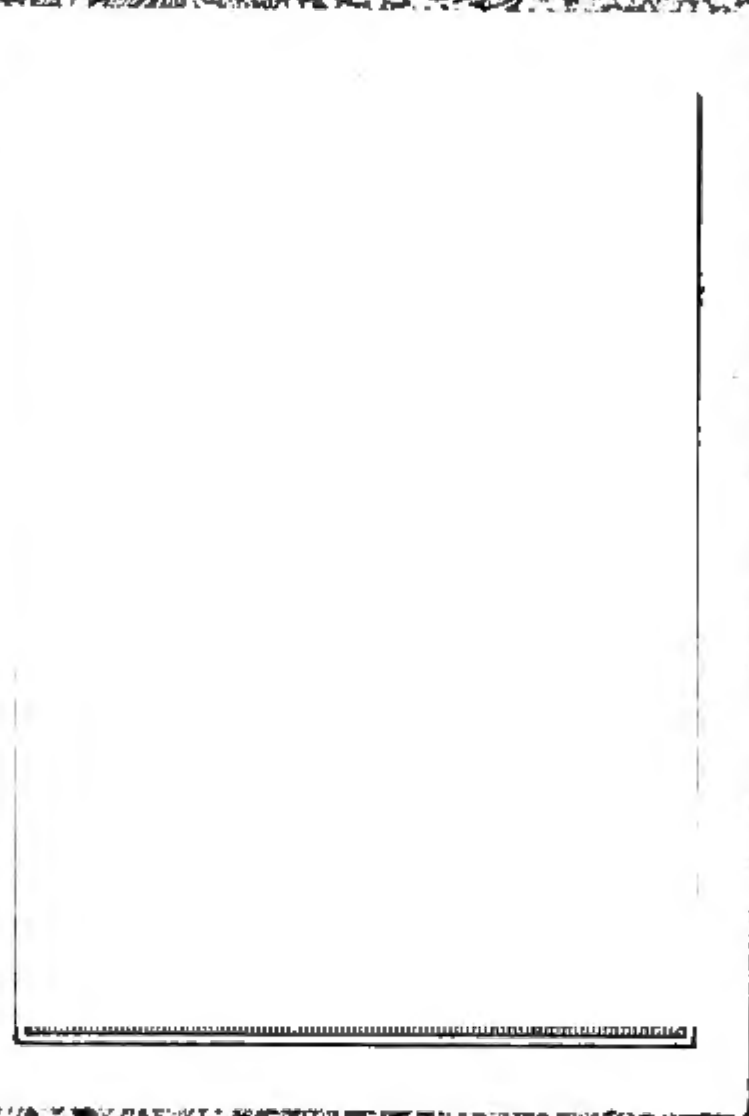
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THE
HUMAN EAR
AND
ITS DISEASES;

A PRACTICAL TREATISE

UPON THE

*EXAMINATION, RECOGNITION, AND TREATMENT OF AFFECTIONS
OF THE EAR AND ASSOCIATE PARTS; PREPARED FOR
THE INSTRUCTION OF STUDENTS AND THE
GUIDANCE OF PHYSICIANS.*

BY

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PREFACE.

*“Jam me vobis, judices, indicabo,
et de meo quodam amore gloriæ,
nimis acri fortasse, verum tamen
honesto, vobis confitebor.”—CICERO.*

PITTSBURGH, PA.,
January, 1882.

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THE HUMAN EAR AND ITS DISEASES.

CHAPTER I.

ANATOMY OF THE EAR.

It is a fundamental law in Zoology, that the greater the division of functional labor, the higher is the degree of development, and the position of the individual in the animal kingdom.

In the Protozoa, there is little or no division of labor. The amœba lives, moves, and has its being, in fact, performs all the functional actions of life, with its jellylike, sarcode body. This undergoes temporary mutation for specialized work, fashions a mouth or an anus, a stomach or a limb, as circumstances require, and then changes again to a state of dignified inertia.

The essential vital processes go on as harmoniously and perfectly, in these microscopic mucous masses, as they do in man, with all his glorious endowment of elaborate and specialized parts. The keenest examination of these animalculæ fails to reveal the presence of any nervous structure. There is sensation and motion, without sensory or motor nerves and ganglia; and one family of the amœba possesses the remarkable power of selecting, from the particles of different stones over which it moves, only those of a special kind of flint, of which each individual builds himself a house or shell. Can it be that, in these minute, unorganized wonders, a nervous fluid pervades the tissues, and performs the duties of nerves and ganglia? That taste, smell, sight, and hearing are decentralized, and their pleasures pass from cell to cell as a breeze moves, carrying exquisite delight to the innermost recesses of being?

It is probable from recent researches, that repeated discharges

of neural currents, in certain directions through connective tissues, may modify the nutrition of tracts so much, as to produce ultimately a nerve fibre along the course of least resistance.

The ectocarp of some medusæ contains multitudes of short disconnected nerve fibres, yet nervous currents jump from one to another, and pass all around the fringe of cilia.

There are so many mysteries of the nervous system, and our knowledge of nerve terminations is so defective, that we should not be dogmatic. There seems to be a correlation between specialized sense organs in the higher animals, so that when one of them is destroyed, some or all the others become more acute, and prone to take on in some measure the functions of the lost one.

This is readily conceived, when we reflect, that these special sense organs are united in the lower forms of animals; that in them nerve terminations, little or not at all specialized, and, perhaps, nervous fluids alone convey to the corporeal structure the various vibrations, which we denominate sensations.

The senses of sight and hearing, so highly specialized and so dissimilar in the nobler animals, show this correlation as we descend the animal scale, until, in the lowest forms, they become united and simplified to such a degree that it is difficult to say whether we have an eye or an ear under observation, and naturalists escape from a dilemma by the happy expedient of calling it a sense capsule.

The first appearance of any special sense organs is in the Protozoa, but in the coelenterate Radiates, they are more numerous and characteristic. The tentacles of these animals have numerous sacs upon the surface, each of which contains a coiled thread. When touched, the sacs rupture and the threads dart out in a straight line, causing a pricking sensation in the human skin where they come in contact with it. They are thought by naturalists to be allied to tactile corpuscles. They are present in less numbers in Articulata and Mollusca. Their analogy to the organ of the common stinging nettle is interesting.

The echinoderm Radiates are the first animals which possess a true nervous system of ganglia and fibres. Some of the latter terminate in pigmented capsules, containing carbonate of lime crystals, situated at the distal extremity of certain tentacles, and

surrounded by movable spines called eyelids. There is no positive evidence of the function of these curious structures, though naturalists are inclined to consider them eyes, as they call them ocelli. The crystals are freely movable in the sacs, and the capsules are thus homologous with the internal ear of higher animals. The presence of pigment might be considered an ocular analogue. They are probably foreshadowings of the eye, because imperfect seeing would be much more useful to the weak organisms, wandering along the surface, or crawling in the depths over the myriad skeletons of their ancestors, than imperfect hearing, which at the best in such rudimentary organs would be of very little use.

The lower forms of Mollusca and Articulata have similar pigmented sacs, containing colored carbonate of lime lapelli, of indeterminate or combined auditory and ocular functions; but the higher forms have the organs so specialized as not to leave any doubt of their analogies.

An organ of hearing consists essentially of an auditory capsule, or labyrinth, which receives sonorous vibrations upon its surface, that pass by means of its fluid contents across it and impress the terminal filaments of the auditory nerve. The vibrations are intensified by the presence of one or more freely movable, sclerous particles almost always present, called otoliths, otoconites, lapelli, ear-stones, ear-sand, etc. This general definition of an ear covers the representatives of the organ in all the Invertebrata, though various slight modifications obtain, in anatomical structure and bodily position in the different orders. For instance, the ear-stones are of various shapes and colors, and there may be one or many in a capsule. The otic capsule may be smooth within, or lined by delicate cilia, upon which the lapelli vibrate; it may have an opening outwards (*Homarus* and *Palæmon*), or be a closed sac; it may be exposed upon the surface of the body (*Orustacea* and *Insecta*), inclosed within the cephalic cartilage (*Cephalopoda*), or within the calcareous skeleton (*Lucifer*).

The organ of hearing of Vertebrata consists of an otic capsule and auditory nerve, corresponding to the invertebrate ear, and of certain appendages, which increase its complexity and functional power. Fishes have the capsule, with one, two or

three semicircular canals, the whole inclosed in bony walls, and having generally no communication with the pharynx, or with the exterior surface of the body. In amphioxus, the otoliths are absent; in osseous fishes, a single large one nearly fills the vestibule. In some fishes, the vestibule of one side unites with its fellow, and communicates with the swim bladder by a chain of bones; or the swim bladder is prolonged into the cranium, and connects with the auditory capsule, which arrangement greatly intensifies the sound.

Some Batrachians have a simple otic capsule, partially or entirely inclosed; others have a middle ear added to this, with a tympanic membrane upon the side of the head, a single bone (*columnella*) extending from it to the membrane of the single vestibular opening, and Eustachian tubes, sometimes united in the middle line, communicating with the pharynx.

Reptiles have the internal ear inclosed in bone; a rudimentary cochlea; a middle ear with columnella (stapes) from the vestibule to the tympanic membrane upon the surface of the head, and well-developed Eustachian tubes.

Birds have the otic capsule inclosed in bone; a spiral cochlea; a columnella; a tympanic membrane on the side of the head, shielded by a fold of skin, and Eustachian tubes, which unite before reaching the pharynx. Large foramina extend from the middle ear to spaces between the tables of the skull.

Mammalia have the internal ear inclosed in osseous tissue; the vestibule is proportionately small; the cochlea is much increased in size and complexity, and has part of the auditory nerve distributed to it. Instead of a single bone, a chain of ossicles, connected with muscles, extends across the middle ear from the foramen ovale to the tympanic membrane. This membrane forms the bottom of a canal that opens upon the surface of the head and is generally surrounded by an auricle. The auricle and canal constitute the external ear. Separate Eustachian tubes communicate with the pharynx, and there are foramina from the middle ear to the mastoid cells. There are a few modifications of this arrangement in the lower animals of the class.

After this abridged sketch of the dawn and development of the organs of hearing in the animal kingdom, one may the better

appreciate the delicate anatomy and exquisite functions of the auditory apparatus in man.

The Human Ear is divided for convenience of study into the external ear, the middle ear, and the internal ear. The first comprises the auricle and external auditory canal; the second, the tympanum with two diverticula, the mastoid cells and process behind, and the Eustachian tube in front; the third, the vestibule, semicircular canals and cochlea.

FIG. 1.

THE AURICLE (Leidy).*—1, Helix; 2, scaphoid fossa; 3, antihelix; 4, triangular fossa; 5, concha; 6, tragus; 7, antitragus; 8, external auditory meatus; 9, lobule. The dots in the depressions represent sebaceous glands.

The Auricle, or pinna, is composed of reticular cartilage, muscles, and skin, with vessels, nerves, and glands. It varies in form, size, color, and angle of attachment, and joins the external auditory canal between the articulation of the lower jaw and the mastoid process. It resembles a shell, with ridges, depressions, scrolls, and promontory.

The tragus is a curved prominence of cartilage, with its concavity backwards, situated in front of the external meatus, which

* An Elementary Treatise on Human Anatomy. By Professor Joseph Leidy, University of Pennsylvania. J. B. Lippincott & Co., Philadelphia, Pa., 1861.

opens inwards from the bottom of a deep depression called the concha.

The concha is the largest and deepest depression in the auricle; it has a semi-spiral course towards the meatus. It is divided by a ridge of cartilage, which starts from its posterior border, curves forward, upward, backward, and downward, to end in a point above the lobule. This forms the outer rim of the upper half of the auricle, and is called the helix. Upon its anterior border is a little eminence called the process of the helix. There is another ridge inside the helix, which curves downward parallel with it, and becomes elevated into a nodule opposite the tragus, called the antitragus. The ridge is called the antihelix. It turns forward, divides into two limbs, and includes the triangular fossa, or fossa of the antihelix. The depression between the two helices is called the fossa of the helix, or scaphoid fossa.

The curved outlet of the concha below the meatus, between the tragus and antitragus, is called the notch.

The fibro-cartilage of the ear has several fissures, is covered by tough perichondrium and ligamentous bands which strengthen it, and has appended to it below, a mass of connective tissue and fat, covered by the skin, called the lobule.

The seven intrinsic muscles of the ear are attached to different processes of the cartilage, and all but one run towards the auditory canal. They lie close upon the cartilage; are striated, thin, pale, and difficult to dissect. They are of little or no use in man, and have been denominated vestigia, vestiges of muscles, which in some mammals are well developed, and perform important offices in shaping the auricle in audition.

The auricular cartilage is firmly attached to the skull by three ligaments. The anterior ligament extends from the process of the helix to the root of the zygomatic process. The posterior ligament attaches the convexity of the concha to the mastoid process. The annular ligament connects the cartilage with the osseous portion of the auditory canal.

There are three extrinsic muscles of the auricle: the attollens aurem, or superior levator; the attrahens aurem, or anterior auricular; and the retrahens aurem, or post auricular muscle.

The attollens is large and fan-shaped. It arises from the border

of the occipito-frontal aponeurosis, and is inserted into the cartilage on the posterior surface of the fossa of the antihelix. It draws the auricle upward.

The *attrahens* is a thin band of muscular fibres, which arises from the temporal fascia, and is inserted into the helix and concha.

The *retrahens* arises from the mastoid process, and is inserted into the back of the concha.

The auricle is covered by skin, which is very thin and adheres closely in the depressions, but is thicker, and separated from the cartilage in other parts by connective tissue containing considerable fat. The skin forms a sort of pouch for the lobule, which rarely has any cartilage extending into it. The skin extends into the auditory canal like the finger of a glove, and covers with a delicate layer the outer surface of the tympanic membrane.

The External Auditory Meatus, or canal, extends from the bottom of the concha to the obliquely placed tympanic membrane, and is divided into two portions, the external fibro-cartilaginous, about 10 mm., and the internal osseous, about 20 mm. in length, thus making the whole canal in the adult about 30 mm. ($1\frac{1}{4}$ inches) long. Its average diameter is 6 mm.; it is narrowest in the middle of the bony portion, and expanded at both ends; is oval from above downward, and runs in a sinuous course something like the letter S, twisted a little in a spiral. It can be nearly straightened by drawing the auricle upward and a little backward. It is often straighter, especially in negroes, which may account for their musical talent.

The fibro-cartilaginous portion has a few fissures filled with elastic tissue. It is joined to the osseous canal by the annular ligament, is covered by perichondrium, and is immediately surrounded by fat and connective tissue. The bony portion consists of thin plates which have become joined together, as they have developed outwards and laterally from the tympanic ring. The superior wall of the canal is surmounted by cells, which communicate with the cells of the mastoid process, and it separates the canal from the middle cerebral fossa. The posterior wall is thick and honeycombed with large cellular spaces, some of which open into the middle ear. It separates the canal from the sigmoid

fossa of the transverse sinus. The anterior superior wall forms the roof of the temporo-maxillary articulation; the bone is here frequently very thin, and is separated from the condyle of the jaw by a thin interarticular cartilage.

The bony canal is covered with periosteum, to which the thin skin is so tightly adherent that it looks pinkish like a mucous membrane. This is quite sensitive, becomes very thin at the deepest part, and passes as a delicate epithelial layer over the tympanic membrane, where there are no glands or hairs. The skin of the auricle and cartilaginous portion of the canal is separated from the cartilage by more or less connective tissue and fat, has hair follicles and hairs, sudoriferous and sebaceous glands. The latter are large and numerous in the concha, and the sudoriferous glands are very numerous upon the posterior surface of the auricle. The tragus is sometimes ornamented by a tuft of hair. The hair follicles and hairs, and the glands are like those of the skin of other parts, except that some of the sudoriferous glands within the canal, mostly limited to the cartilaginous portion, become altered in character, and take the name of ceruminous glands. The coiled tube of a ceruminous gland is thick, and the excretory ducts are shorter than in its allied sweat gland. There are from one to two thousand ceruminous glands. They are most numerous at the junction of the cartilaginous and bony canal, and secrete a light, reddish-yellow, bitter, sticky wax, or cerumen, which exudes like plum sap on the bark, and forms a covering for the surface of the cartilaginous portion of the canal. It is a kind of bog for venturesome insects, and an *omnium gatherum* for dust and dirt.

Vessels.—In the connective tissue, beneath the skin covering the cartilage, and within the skin and periosteum of the osseous canal, run the lymphatics, bloodvessels, and nerves.

The arteries and veins of the external auditory canal begin at the umbo, or about the centre of the tympanic membrane, and form a capillary network, which passes to the periphery and forms a ring. This network communicates with another in the middle ear, through the periphery of the membrane, around the malleus handle, and through Shrapnell's membrane. From the ring upon the outer surface vessels go along the auditory canal to the meatus,

where they receive branches from the anterior surface of the auricle; some of these then join the temporal vessels separately; others unite into a single trunk and pass to it under the name of the anterior auricular artery or vein. A few branches pass through fissures in the auricular cartilage; others curve around its edge and join the posterior auricular.

The arteries and veins of the posterior surface of the auricle, though a few above anastomose with the terminal capillaries of the occipital and posterior temporal, for the most part, unite to form larger vessels, which run towards the mastoid and join the posterior auricular. This is a branch of the external carotid in one case, and of the temporo-maxillary vein in the other. The artery lies in the sulcus, between the auricle and the mastoid, and the vein a little farther posterior. The posterior auricular receives below the stylo-mastoid vessels, which come from the internal and middle ear and the mastoid cells. The occipital vein receives the mastoid vein through the mastoid from its cells and the lateral sinus of the brain.

Delicate lymphatics arise upon the surface of the tympanic membrane, pass out of the external canal, form trunks, unite with those from the anterior surface of the auricle, which are very numerous, go forward and downward, and debouch into three or four parotid lymphatic glands on and beneath the parotid gland. Other lymphatics, from the posterior surface of the auricle and the region of the mastoid process, empty into three to five posterior auricular lymphatic glands upon the mastoid and upper end of the sterno-cleido-mastoid muscle. From these glands, lymphatics communicate below with the superficial cervical glands in the posterior triangle of the neck, and, what is more important, with the chain of submaxillary lymphatic glands beneath the angle of the jaw. These communicate with the deep cervical lymphatic glands; and, finally, the united currents pass by fewer and larger ducts into the right lymphatic duct, which empties into the subclavian vein. Thus an interrupted communication exists, like a canal with locks, from the external auditory canal to the venous system, which has a decided significance for the clinician.

Anastomoses are frequent between the branches of the superficial vessels and those lying deeper.

The nerves of the auricle and external canal are derived principally from the auriculo-temporal, a branch of the inferior maxillary; the posterior auricular, a branch of the facial, and the auricularis magnus. The auriculo-temporal nerve arises by two roots from the inferior maxillary nerve, beneath the base of the skull, inside of and anterior to the articulation of the lower jaw. It gives off immediately a branch to the otic ganglion; passes beneath the internal pterygoid muscle, backward and outward around the neck of the jawbone, where it gives a branch to the facial; an inferior auricular branch, distributed to the auricle below the meatus; a few filaments to the sympathetic plexus on the internal maxillary artery, and a superior auricular branch, which supplies the skin of the tragus and contiguous parts of the pinna.

The main portion of the nerve, with the temporal artery, passes upward through the parotid gland, gives a few filaments to it and the articulation of the jaw, then passes in front of the tragus and divides into two branches: the anterior temporal, which takes the general course of the temporal artery, and communicates with the facial; and the posterior temporal, which supplies the *atrahens aurem* muscle, and the skin of the upper anterior surface of the auricle and contiguous parts above. Filaments from the superior auricular, inferior auricular, and posterior temporal, are distributed to the auditory canal and tympanic membrane, where the filaments terminate in forked processes, and make the surface exquisitely sensitive. The posterior division of the inferior maxillary, the auriculo-temporal, is most sensitive; and it is through the nerves, traced out, that most of the pain is felt from operations on the front of the auricle and in the external auditory canal. The auricles of moles are so sensitive that they serve as tactile organs.

The posterior auricular nerve comes off from the facial just after it makes its exit at the stylo-mastoid foramen. It receives immediately a branch made by a union of one filament from the pneumogastric, one from the glosso-pharyngeal, and one from the auricularis magnus, and then passes up between the mastoid process and the auricle, and divides into two branches: an occipital, which goes to the back of the head, and an auricular, which sup-

plies the *retrahens aurem* and the skin over the mastoid, and upon the posterior surface of the auricle.

The *auricularis magnus* arises from the second and third cervical nerves, winds upwards around the posterior border of the sterno-cleido-mastoid muscle, passes into the parotid gland, sends filaments to the posterior auricular and pneumogastric, and divides into several branches. The auricular passes under the auricle, runs upward and backward, and supplies the integument of the mastoid process and the back of the auricle.

The *occipitalis minor* arises from the second cervical, ascends along the posterior border of the sterno-cleido-mastoid muscle to the back and side of the head. It gives off an auricular branch, which passes upward and backward, and supplies the skin of the upper part of the auricle; that behind this part and above it goes to the *attollens aurem* muscle.

Sympathetic nerves, not only, communicate with the other nerves that supply the auricle and external auditory canal, but, also, accompany the vessels to those parts. Galvanization of the superior sympathetic ganglion causes a marked hyperæmia of the auricle.

The Tympanum, or middle ear, is situated in the base of the temporal bone, and its cavity is very irregular in shape. The walls are covered by periosteum and mucous membrane. Its length is about 10 mm., the vertical depth 6 to 8 mm., and width 2 to 6 mm., and it contains the ossicles, or ear-bones. It may be described as having six walls.

The superior wall is a thin plate of compact bone, forming the roof, and it separates the cavity from the middle cerebral fossa. It has many cells and vessels in that part which joins the squamous portion of the temporal bone, and these are more abundant in infants than in adults. It is sometimes fissured, when the mucous membrane of the tympanum and the dura mater alone separate the cavity from the brain.

The inferior wall, or floor, is generally thick enough, considerably inclined forward and inward, and its surface is a mere groove, lying below the openings of the Eustachian tube and mastoid antrum, and the lower border of the drum-head. It separates the tympanum from the internal jugular vein, which

enters the skull beneath. In the floor close to the inner wall is a foramen for the entrance of Jacobson's nerve, the tympanic branch of the glosso-pharyngeal.

The external wall comprises the annulus and frame of bone, which holds the tympanic membrane, and closes the inner end of the external canal. The membrane is attached firmly to the groove, which in the infant is situated in the inner surface of the processus auditorius. This is a ring of bone, deficient above, which closes and grows outward as development progresses, and forms the bony part of the external auditory canal.

The portion of the external wall behind the membrane curves towards the posterior wall, and forms part of the boundary of the foramen of the chorda tympani nerve, or the *iter chordæ posterius*. In the portion of bone in front of the membrane, is the anterior foramen, the *iter chordæ anterius*. This is high up, and is the beginning of the canal of Huguier, which runs forward and downward through the bone, comes out inside the articulation of the jaw, and transmits the chorda tympani nerve. Parallel to it and just below is the Glaserian fissure, a mere slit, which goes from the tympanum through the bone and opens inside the articulation of the jaw. It transmits some tympanic vessels and nerves, and the laxator tympani muscle. The long process of the malleus lies in its tympanic sulcus.

The Tympanic Membrane, *membrana tympani*, or drum-head, is inclined somewhat forward, downward and inward, in adults; it is more slanted in early life, and so oblique in infants as to be seen with difficulty. It is oval in shape, its vertical diameter is about 10 mm., and its transverse 9 mm.; it is depressed inward like a funnel, and its external surface presents the concavity of a very short hollow cone, at the apex of which is seen the yellow clubbed end of the handle of the malleus.

It is composed of an external dermic layer, without glands or hairs, an inner mucous, and a middle fibrous layer; the latter forms the skeleton of the membrane. It has an outer set of radial fibres next the skin, inserted into the handle of the malleus and the tendinous ring around the periphery of the membrane, in the annulus, and continuous with the cellular tissue of the auditory canal; and an inner set of circular fibres next the

mucons membrane, firmly united to the others, much thicker around the periphery, and few and thin near the centre of the drum-head. A few of these circular fibres are attached to the malleus; a few others go from the neck of the malleus to the posterior border of the membrane, within the fold of mucons membrane that is reflected over the chorda tympani nerve; and a perpendicular set runs along the handle of the malleus. Between the two fibrous layers, in a sort of socket of fibro-cartilage, the long process, manubrium, or handle of the malleus, and the

FIG. 2.

OUTER SURFACE OF THE RIGHT TYMPANIC MEMBRANE (Burnett).^{*}—A, Manubrium of malleus; B, end of manubrium; C, short process; D, posterior fold. The triangle of light is seen below.

short process, are held in a position, running from above anterior, downward and backward. It is movable in the groove or socket like an enarthrodial joint.

These fibrous layers make the membrane firm and resistant, so as not to rupture from ordinary shocks. When rupture does occur it is near the end of the malleus handle, generally anterior, or posterior, or around its central boss, leaving a margin around the periphery. The membrane is elastic, so that adhesions often take place with the inner wall of the middle ear without any rupture. In the upper segment, the fibrous layers are so thin that the skin and mucons membrane come together.

The mucons membrane of the middle ear forms the inner layer of the tympanic membrane. It is thin and closely adherent to the fibrous layer in the centre, and looser at the periphery, where it is reflected upon the bone.

^{*} The Ear; its Anatomy, Physiology, and Diseases. By C. H. Burnett, A.M., M.D., Philadelphia. Henry C. Lea's Sons & Co., Philadelphia, Pa., 1877.

The chorda tympani nerve passes horizontally from behind forwards in the middle ear, near and inside the handle of the malleus, and the mucous membrane leaves the tympanic membrane, goes over the nerve, and returns again to it; this makes a sort of mucous shelf, divided into two pouches, where mucus and pus are likely to lodge. The posterior large pouch is between the malleus and the border of the tympanic membrane, contains a few fibres of the middle layer of the latter, and is shaped like a tent with the point downwards. This may be seen with good illumination. The anterior smaller pouch is in front of the malleus and has no fibrous tissue; it is lower down than the other, and contains within the fold all the parts which enter

FIG. 3.



INNER SURFACE OF THE RIGHT TYMPANIC MEMBRANE (Burnett).—A, Manubrium; B, end of manubrium; C, head of malleus; D, body of incus; E, short process of incus; F, lenticular process of incus; G H, chorda tympani nerve; I, point of insertion of the tensor tympani muscle.

the middle ear through the Glaserian fissure. There is another very small pouch above the short process of the malleus, with an opening posterior, and above the posterior pouch.

Shrapnell's membrane, or the flaccid membrane, is the part of the drum-head above the mucous shelf forming the first two pouches. It is freely movable, contains little fibrous tissue, and the mucous and dermic layers are loose and come near together. It was once thought to contain an opening, the foramen of Rivinus, but this is not now believed.

Externally the handle of the malleus forms a slight ridge running from its depressed cartilaginous end, or umbo, to the yellow, button-like projecting short process above, and divides the membrane into two portions, an anterior, and a larger, posterior seg-

ment. The short process of the malleus forms a slight antero-posterior ridge, which is the lower boundary of Shrapnell's flaccid membrane before mentioned. On the outer surface, a triangle, or cone of light, is seen with its apex at the end of the manubrium, and its base, 3 mm. wide, on the periphery of the membrane in the anterior inferior quadrant. It shines like a metallic mirror, and is caused by the funnel shape of the membrane and the reflecting qualities of the dermic layer. It is the first thing to alter in appearance when there is disease in the middle ear.

The membrane may be for practical purposes divided into three portions: an upper segment above the short process of the malleus and the transverse folds before mentioned, called Shrapnell's membrane; an anterior lower segment in front of the malleus handle and the cone of light; and a posterior lower segment behind the handle and the cone; these last two are bounded above by the mucous folds within, and by the short process of the malleus.

The color of a normal tympanic membrane is from a bluish to a yellowish-gray, differing at different ages, and by anatomical variations in and around it. It is lighter in infants, because the dermic layer is thicker, and generally shaded with pink. It has an amber-gray, translucent appearance near the centre, in front, and behind the malleus.

The vessels of the dermic surface, the anterior and posterior auricular, pass into the auditory canal and form a ring around the periphery of the membrane; this sends branches to a similar ring in the mucous layer within, and many branches towards the centre of the membrane in the derma, which unite freely into capillary meshes.

The stylo-mastoid artery, a branch of the posterior auricular, passes through the stylo-mastoid foramen and the posterior wall into the middle ear; the tympanic, a branch of the maxillary portion of the internal maxillary, passes up behind the articulation of the jaw through the Glaserian fissure into the tympanum, supplying the laxator tympani muscle in its course; the Vidian, a branch of the spheno-maxillary portion of the internal maxillary, goes along the Vidian canal with the nerve, and sends a small branch into the tympanum. A branch of the stylo-mastoid

artery and the tympanic branch of the internal maxillary unite to form a ring around the periphery, in the mucous membrane covering the tympanic membrane. This ring communicates with the external ring described above, and it forms a set of capillaries which ramify over the internal surface of the membrane. One vessel, quite large, called the tympanic trunk, runs downwards from the ring, along the anterior border of the manubrium, turns around its lower end, and communicates freely with the general capillary network of the mucous layer. The veins are fewer, but take the same general course.

There is a capillary net of lymphatics in the mucous layer of the membrane, communicating with that found upon the other walls.

Nerves.—There are no nerves to the fibrous layer of the drum-head; the mucous layer is supplied by a few filaments from the common tympanic plexus.

The posterior wall of the tympanum is wider above than below, and the floor of the tympanum rises towards and lessens its height. In the upper part, there is a large irregular opening called the mastoid antrum, which may be regarded as a vestibule leading from the middle ear to a suite of rooms, the mastoid cells, which lie above, behind, and below the antrum in the shell of compact bone that forms the mastoid process. The wall has a few smaller openings into the mastoid cells, a foramen for a branch of the facial nerve to the tympanic muscles, and just in the angle, low down, between the posterior wall and the rim of the outer wall around the membrane, are the foramina for the stylo-mastoid vessels and the chorda tympani nerve.

The facial nerve, in its aqueductus Fallopii, passes downward near the angle of the posterior and the inner walls, gives off the chorda tympani nerve below the level of the middle ear, and the filament above for the stapedius and laxator muscles.

The Mastoid Process is like a crushed honeycomb; the cells are quite large and irregular in shape, and they lie very near the lateral sinus and the external surface. The external part of the mastoid process is behind the auricle, it extends below the level of the external meatus and the ear proper, and the auricle has firm attachment to its anterior surface. Behind and a little

above the meatus, at the upper border of the mastoid, the temporal bone is quite thin, and an opening through would enter the upper arm of the sigmoid portion of the lateral sinus.

A vein from the external surface enters the mastoid foramen and empties into the lateral sinus in this part of its course, thus making a free connection between the mastoid surface and the venous current, important to consider with post-auricular abscess.

FIG. 4.

MASTOID SPACES AND TYMPANUM (Leidy).—1, Promontory; 2, pyramid; 3, ridge of Fallopian canal; 4, round window; 5, oval window; 6, Eustachian tube; 7, surface for Eustachian cartilage; 8, canal of tensor tympani muscle; 9, Fallopian canal exposed; 10, canal for great petrosal nerve; 11, mastoid cells; 12, mastoid antrum; 13, foramen for the tympanic branch of the facial nerve.

The mastoid cells are lined with a delicate, quite vascular mucous membrane, continuous with that of the middle ear, and its vessels communicate freely with the diploic vessels of the cranial wall.

The mastoid process does not reach the above-described development until the age of puberty. In the child, it is a thin double shell of bone, containing very small cells. It develops outwards

with the tympanic ring, which forms the external auditory canal. A knowledge of this difference is of vast importance in the treatment of children afflicted with ear diseases, because all the walls about the ear are of about the consistency of pasteboard, and they may be easily perforated by careless or rough manipulation and cause fatal injury.

The anterior wall of the tympanum is wider above than below, is smaller than the posterior wall, and consists of a thin plate of bone, separating the tympanum from the carotid canal, which is just inside of it. It has a foramen for the passage of lymphatics, and a small artery from the carotid. At the upper part of the wall, there is an opening surrounded by a conical rim of bone, which projects a little backward into the tympanum, and has been called the anterior pyramid. The foramen leads to a canal in the temporal bone, which extends forward, inward, and a little downward to the base of the temporal bone, and opens in the fissure between it and the great wing of the sphenoid, being a little farther prolonged by cartilage. It contains the tensor tympani muscle, which arises from the angular process of the great wing of the sphenoid just behind the foramen ovale, from the cartilage of the canal and of the Eustachian tube below, and the upper wall of the canal, and passes along this to the foramen, where its tendon enters the ear. This turns at right angles to its tubular course, outwards from the anterior pyramid, and is inserted into the anterior surface of the inner edge of the manubrium near its root. Just below the anterior pyramid, but considerably above the floor of the tympanum, is a larger opening for the Eustachian tube.

The inner wall of the tympanum is vertical, and is seen through the external canal, when the drum-head is destroyed. The first thing to attract attention is a pale, pinkish prominence, seen about the middle of the lumen, which is an elevation called the promontory, caused by the lower coil of the cochlea. This is nearer the tympanic membrane, in the normal ear, than any other part of the wall, and can often be seen through it as a pale-yellow spot. In the wall just anterior to this is a pitchfork-shaped groove, with tines downward, in which run branches of the tympanic plexus of nerves.

On a level with the lower border of the promontory, and behind it, is a rounded opening into the cochlea, 2 mm. in diameter, called the foramen rotundum, or round window. It is closed by a membrane, sometimes called the *membrana secundaria*, composed of three layers: an outer mucous, a middle fibrous, and an internal serous layer. The latter is bathed by the fluid that fills the tympanic scala of the cochlea.

On a line with the promontory, above and a little behind it, so that a vertical line along its posterior border would bisect it, the foramen ovale, or oval window, is found. Its shape is nearer reniform than oval, and the long diameter is antero-posterior,

FIG. 5.

Florida

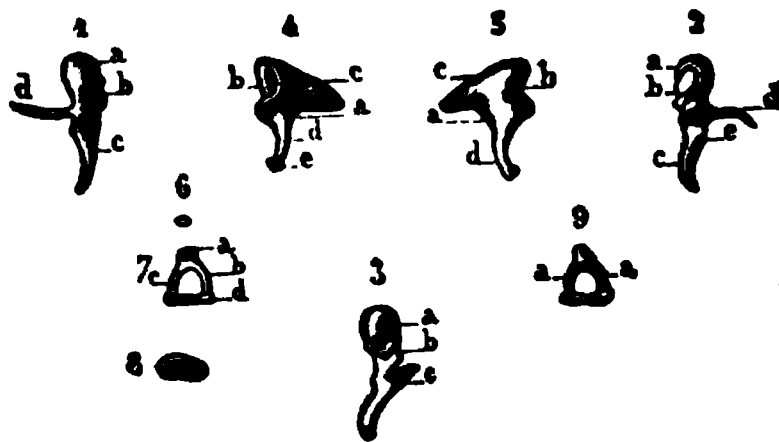
RIGHT INNER TYMPANIC WALL (Burnett).—Note the orifice for the tendon of the tensor tympani muscle, that for the stapedius, and the chorda tympani nerve.

inclined a little downward and backward. It is 3 mm. long and 1.7 mm. wide. A perpendicular line dropped from its posterior end would make a chord of an anterior arc, representing nearly one-third of the round window. The foramen ovale opens into the vestibule and is closed by membrane; the vestibular surface of this membrane is serous, its middle layer is fibrous, and its tympanic surface is covered by the bony foot-plate of the stapes. It is opposite the tympanic membrane, and connected with it by the chain of ossicles. Sometimes parts of the anvil and stapes

or the oval window can be seen through a perforated drum-head. The pyramid, or eminentia stapedii, lies behind the round window, and is curved so that its summit nearly reaches the oval window. A canal extends from its apex to its base and opens into the aqueduct of Fallopius. It contains the stapedius muscle, the tendon of which escapes at the apex and passes to the stapes. The base of the pyramid is partly in the posterior wall, and borders the foramen for the chorda tympani nerve. Behind the pyramid, there is an elevation of the posterior wall into a ridge, that curves upward and forward along the inner wall, and forms its posterior and upper boundary. This is the bone covering the aqueduct of Fallopius containing the facial nerve. Sometimes the bone here is deficient, and the facial is exposed to the middle ear. The inner wall is covered by mucous membrane, continuous with that upon the other walls, and reflected over the muscles, tendons, and ossicles.

The Ossicles of the Ear.—The middle ear contains three small bones, united by ligaments into a series, or chain, and moved

FIG. 6.



THE OSSICLES (Leidy).—1. Inner surface of malleus: *a*, head; *b*, articular facet; *c*, manubrium; *d*, slender process. 2. Outer surface of malleus; letters as above, but *e*, short process. 3. Posterior surface of malleus: *a*, head and facet; *b*, short process; *c*, slender process. 4. Inner surface of incus: *a*, body; *b*, articular facet; *c*, short process; *d*, long process; *e*, lenticular process. 5. Outer surface of incus; letters as above. 6. Lenticular process broken off. 7. Stapes: *a*, head; *b*, *c*, crura; *d*, base. 8. Base of stapes. 9. Stapes cut to show obturator groove, *a*, *a*.

by muscles. They extend from the tympanic membrane to the membrane of the foramen ovale, and are called the malleus, incus, and stapes. The orbicular, or lenticular bone, once described as a sesamoid bone in the articulation of the incus and stapes, does not exist.

The malleus, or hammer, consists of a head, neck, two processes, and manubrium, or handle. It is 9 mm. long, and the neck divides it into two nearly equal parts. The head is club-shaped and rounded; it is $2\frac{1}{2}$ mm. thick, and its long diameter is nearly vertical in position. Its posterior, internal surface has a vertical, oval depression, or facet, for articulation with the incus. The neck is a constriction below the head. The head and neck project into the middle ear, are free from the tympanic membrane, and extend a little above its upper margin. Just below the neck there is a small protuberance, called the short process, which projects outward against the membrana tympani, and looks like a minute yellow pearl.

The slender process, or processus gracilis, is long and slim, like the blade of a Catlin knife; it projects forward from the inner surface below the neck into the Glaserian fissure, where it is connected with the bone below by ligaments, which permit slight movement. Below these two processes the manubrium extends downward and backward; it is thick and rounded at first, then bayonet-shaped, with one edge outward, and gradually diminishes to terminate in a slightly clubbed extremity. The whole length of this process lies between the two fibrous layers of the tympanic membrane, as before described, and shows clearly through it.

The malleus is held in position by ligaments. The anterior ligament extends from the neck of the malleus and root of the processus gracilis, through the Glaserian fissure, to the spine of the sphenoid, and is also attached to the frame of the tympanic membrane and the walls of the fissure. The fibres running to the sphenoid are mentioned in some anatomical works as the laxator tympani muscle, but later researches have proved them to be a ligament.

The superior ligament passes from the roof of the tympanum downward and outward to the head of the malleus. The external ligament extends from the temporal bone, above and inside the segment of Rivinus, where the annulus is deficient, to the front of the neck of the malleus. The posterior ligament is the posterior fibres of the external; the two really constitute a fan-shaped

ligament, extending from the contiguous bone to the malleus, and sometimes called the axial ligament.

The neck of the malleus moves but little, the ossicle seeming to rock upon this part as a lever upon a fulcrum.

The incus, or anvil, is so named on account of its resemblance to an anvil. It has a body and a short and long process; the processes are nearly at right angles to each other. The length



FIG. 7.—Two inches divided into lines (''').

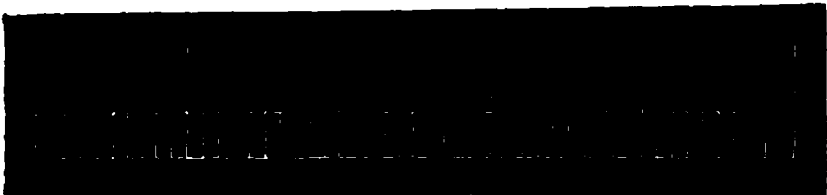


FIG. 8.—Five centimeters divided into millimeters (mm.).

of the short process and body is about 5 mm., that of the long process and body, 7 mm.; the body is $2\frac{1}{2}$ mm. in diameter at its thickest part.

The bone looks more like a bicuspid tooth than an anvil; the body has opposite the processus an oval facet, which looks forward and outward, and is articulated by a capsular ligament with the head of the malleus. The thick, pointed, short, or horizontal process extends backward and downward; this process and the body of the bone are very near the roof of the tympanum.

The long process, or descending ramus, curves a little outward and downward, becomes slender, then turns abruptly inward, forms a button-like, or lenticular extremity, which articulates with the head of the stapes by a capsular ligament. A sesamoid bone is found rarely in the joint, which has been described as the lenticular bone, or os orbiculare. Anatomists now deny the existence of this formation, and consider it when found the lenticular process that has been broken off during dissection. This process is said to exist as a separate bone in the foetus.

The incus is held in position by its tympanic and articular ligaments. The superior ligament passes from the roof of the

tympanum to the middle of the short process; the posterior ligament fastens the point of the short process to a slight prominence upon the posterior wall of the ear just above the largest opening, the antrum, into the mastoid cells.

The principal part of the incus is near the roof of the tympanum, and hence above the inner end of the external canal, *i. e.*, above the upper edge of the tympanic membrane, along with the head of the malleus.

The stapes, or stirrup bone, is the smallest bone in the human skeleton. It consists of a head, neck, two arms, and a base. It is 4 mm. long from its head to the inner surface of the base. The base is $2\frac{1}{2}$ to 3 mm. long, 1 mm. wide, and about $\frac{1}{4}$ mm. thick. It is shaped much like the old-fashioned iron stirrup, and extends horizontally from the lenticular process of the incus to the oval window. The head is a short horizontal cylinder; its outer surface has a cup-shaped depression, into which projects the lenticular process of the incus. A capsular ligament connects the two bones and forms a ball-and-socket joint. The junction of the head with the arms is called the neck, though no depression exists.

The crura, branches, or arms, spring from the neck, one from the anterior and one from the posterior portion, curve away from each other in a horizontal plane, and finally join opposite ends of the oval plate, which forms the base. The anterior arm is shorter and less curved than the posterior. They diminish in thickness as they approach the base, and are slightly furrowed upon their inner surfaces for insertion of the obturator ligament.

The base, or foot-plate, of the stapes is a thin lamina of bone, dumb-bell or kidney shaped in a perpendicular plane, and like a concavo-convex lens in a horizontal one. It projects at each end a little beyond the junction of the crura. Its convex surface is towards the vestibule. The plate is smaller than the foramen ovale, into which it is held by an annular ligament from the bony margin, and by a fibrous connection with the membrane, which permits a slight in-and-out movement.

The obturator ligament, or *ligamentum obturatorium stapedis*, is a thin plane of ligamentous tissue, that extends between the crura and the base of the stapes and closes the opening.

The ossicles of the ear are covered by periosteum, and delicate cartilage is present upon the articular surfaces. The heavy heads of the malleus and incus are above the axial line of motion, and this greatly facilitates movement.

Muscles.—The laxator stapedis is mentioned by some writers as a muscle, by others as a ligament. If it does not possess muscular fibres, it may act by elastic tension. Described as a muscle, it arises

FIG. 9.

RIGHT ARTICULATED OSSICLES ($\times 4$ diam.) (Burnett).—*k*, Incus; *a*, body; *b*, short process; *c*, long process; *e*, lenticular process; *d*, head of stapes, and malleo-stapedal articulation; *l*, crura; *f*, manubrium of malleus; *g*, slender process; *h*, neck; *i*, head; *j*, malleo-incudal articulation.

from the spine of the sphenoid and cartilage of the Eustachian tube, passes through the Glaserian fissure, and is inserted into the root of the processus gracilis and neck of the malleus. It is said to be supplied by the tympanic branch of the facial nerve.

The tensor tympani muscle arises from the temporal and sphenoid bones at the end of the Eustachian tube, from the cartilage of the tube, and from the walls of a bony canal above the Eustachian tube, passes along this to the ear, and terminates in a tendon, which turns outwards at a right angle over the processus cochleariformis, and is inserted into the anterior inner edge of the handle of the malleus, a little below the processus gracilis. It is supplied by a nerve filament from the otic ganglion.

The stapedius muscle arises from a canal in the pyramid upon the inner tympanic wall behind and a little below the oval window;

its tendon leaves the summit and runs upward and forward, and is inserted into the posterior edge of the articular surface of the head of the stapes. The muscle bends at an obtuse angle after it leaves the pyramid, and is supplied by a filament from the facial nerve and one from the otic ganglion.

The fixator basis stapedis muscle arises from the inner wall, one millimeter above the posterior-superior border of the oval window, and is inserted into the junction of the posterior limb and foot-plate of the stapes. It receives a filament from the facial nerve.

The middle ear is lined by periosteum and mucous membrane; the latter is reflected over the surfaces of the ligaments, muscles,

FIG. 10.

f

RIGHT TYMPANUM VIEWED FROM ABOVE ($\times 2$ diam.) (Burnett).—*a*, Anterior ligament of the malleus; *b*, chorda tympani nerve; *c*, head of malleus; *d*, posterior ligament of incus; *e*, short process of incus; *f*, tensor tympani muscle.

ossicles, and the chorda tympani nerve, forming folds, projections, shelves, and pockets, as before described. It is thin, delicate, and glistening, and upon the walls of the cavity is intimately connected with the periosteum, so that it has more the appearance of a serous than a mucous membrane. It contains no glands, except near the entrance of the Eustachian tube, where racemose ones have been described. It is well supplied with vessels and nerves, and branches of both traverse its basement membrane and pass into its depressions and folds to supply the structures of the tympanum.

Vessels of the Tympanum.—These are the stylo-mastoid, a

branch of the posterior auricular, which enters the tympanum from the posterior wall; the external tympanic, a branch of the internal maxillary, which enters from the anterior wall; the (inner) tympanic, a branch from the Vidian, which enters from the inner wall; the inferior tympanic, a branch of the internal carotid, which enters from the anterior wall; and the tubal tympanic, a branch of the ascending pharyngeal, which enters from the anterior wall, having supplied the Eustachian tube and tensor tympani muscle. These vessels anastomose freely, form a rich capillary net, supply the bones, periosteum, ligaments, muscles, and mucous membrane of the tympanum and mastoid cells, and communicate through the tympanic membrane with the vessels of the external canal, as well, as with those of the petrous bone and contiguous structures.

The veins of the tympanum communicate freely with the mastoid vessels, the vessels of the surrounding bone, and those of the external canal; but the most important ones penetrate the inner and upper walls of the tympanum and join the middle meningeal; others, the Vidian, petrosal, and muscular branches, join the pharyngeal plexus; the former empty into the internal maxillary, and finally into the temporal, and the latter into the internal jugular vein.

The lymphatics of the middle ear pass through the petrous bone along the Eustachian and tensor tympani canals to join the pharyngeal plexus, as before described.

Nerves.—The otic ganglion, having received its sensitive fibres from the inferior maxillary, its sympathetic fibres from the great meningeal plexus, and motor fibres from the internal pterygoid and from the facial through the small petrosal, sends a branch along the canal of the tensor tympani muscle and supplies it with motor influence.

The tympanic branch of the glosso-pharyngeal (Jacobson's nerve), the most important nerve of the tympanum, enters it by a foramen between the jugular fossa and the carotid canal in the floor, near the inner wall, and receives filaments which have passed through the floor from the carotid plexus of the sympathetic system. It lies in grooves upon the inner tympanic wall, breaks up into numerous branches, with which a large number of ganglia

cells are mingled, so that the mesh has been justly denominated the tympanic plexus. In the distribution of filaments, one supplies the mucous membrane of the Eustachian tube, one goes upwards to the small petrosal and one to the large petrosal nerves, one to the oval window, one to the round window, and many others uniting with other nerves supply the mucous membrane of the tympanum and mastoid cells. The connection of the nerve by filaments to the petrosals, with the otic and sphen-

FIG. 11.

NERVES IN THE AURAL REGION (Burnett).—1, Fifth nerve and Gasserian ganglion; 2, tensor tympani muscle; 3, motor branch of fifth; 4, malleus; 5, small petrosal; 6, incus; 7, otic ganglion; 8, facial nerve in canal; 9, chorda tympani nerve; 10, membrana tympani; 11, tensor palati muscle; 12, middle meningeal artery; 13, lingual nerve; 14, auriculo-temporal nerve; 15, inferior dental nerve; 16, external pterygoid muscle; 17, internal pterygoid muscle; 18, internal maxillary artery; 20, mylo-hyoid nerve.

palatine ganglia, makes a close sympathetic connection between the ear, throat, nose, teeth, and eyes, and explains many curious symptoms.

Among the nerves of the middle ear before enumerated is a branch of the facial, which passes through a foramen in the inner wall of the tympanum, sends one filament to the laxator tympani, one to the stapedius, and one to the fixator basis stapedis muscles.

The chorda tympani nerve enters the tympanum at the lower, outer, posterior corner, curves up along the border of the tym-

panic membrane, passes forwards above the tendon of the tensor tympani muscle and below the short process of the malleus, in the fold of mucous membrane, between the malleus and incus, and goes out of the tympanum through the canal of Huguier. It has no physiological office in connection with the ear.

The Eustachian Tube, from its foramen in the middle of the anterior wall of the tympanum, runs beneath the canal of the tensor tympani muscle, downward, forward, and inward from the middle ear to the pharynx, and thus permits a free passage of the air from the throat to the ear. It passes from the tympanum at an angle of 135° with the external auditory canal, but from the external meatus through the ear to the pharyngeal end of the tube the direction often approximates to a curve. In an infant, the direction from the external meatus to the inner end of the tube is nearly transverse.

The Eustachian tube is separated from the tensor tympani muscle by a thin scale of bone often incomplete, but with its deficiencies filled with cartilage and fibrous tissue; this is called the *processus cochleariformis*.

The bony portion of the Eustachian tube is about 12 mm. long, and its inner aperture is in the fissure between the great wing of the sphenoid and the temporal bone. This end is rough; the cartilaginous portion is joined to it and prolongs it about 24 mm., making the whole length of the tube about 36 mm. ($1\frac{1}{2}$ inches). A triangular plate of cartilage is curled upon itself to form the cartilaginous portion, but its edges, which are below, do not meet, and the space is filled by fibrous and muscular tissue. The tube is lined with mucous membrane continuous with that of the middle ear and the pharynx. Its canal is shaped like two truncated cones, flattened a little laterally and joined by the small ends; one part is in the osseous, and the other in the fibro-cartilaginous portion.

The narrowest part of the tube is at the junction of the cones, and is called the *isthmus*, where the vertical diameter is 2 mm. and the horizontal is 1 mm. The aural end has a diameter of 4 to 4.5 mm.; the pharyngeal, 4.5 to 9 mm. in height, and 4 to 5 mm. in width; the expanded pharyngeal end, or *ostium*, is 5 to 6.5 mm. deep. The cartilaginous portion is held in position by fibrous

tissue and the muscles surrounding it, and its inner end is somewhat movable. The pharyngeal end has a decidedly elevated border, especially posterior, and is expanded like the mouth of a trumpet, with its sides pressed a little together, so that the opening is an irregular, perpendicular oval. It varies considerably in the shape of its lumen in different individuals, and upon the two sides in the same person, and corresponds in size with the external meatus; a large meatus accompanies a large-mouthed tube. The mouth is situated a very little below the angle formed by the posterior edge of the external wall of the nasal fossa and the inferior turbinated bone, and a little above the floor of the nose, and external to its outer wall.

The two throat openings are about 25 to 30 mm. apart. If a broom straw be placed across, with an end in each Eustachian tube, its middle will nearly touch the pharynx.

Some persons with very large throats, others with great breadth of the base of the skull, require Eustachian catheters with considerable curve. I noticed that the catheters used by Professors Miot and Desarènes, at their clinics in Paris, were much less curved than those used by Professor Gruber, at Vienna, and Professor Lütze, at Berlin. The French skulls, like those of the Latin races generally, have narrower bases than the Austrian and German.

In very narrow skulls, sometimes a nearly straight catheter will go through the nasal fossa directly into the tube. Occasionally, the inferior turbinated bone of one side is so low down, or the vomer is so bent laterally, that one cannot introduce a catheter, when resort must be had to a special one, applied through the other nasal fossa, or through the mouth. It is very frequently the case that the diseased ear is the one corresponding to the side of the nose deformed—too frequent to be accidental.

When a catheter is in position, the mouth of the Eustachian tube can be moved nearly 6 mm. The point of a catheter in position may be turned upward and outward, exactly horizontal and sometimes even downward and outward. This depends on the position of the palate-bone, the width of the skull, and the shape of the temporal bone.

The Eustachian tube is lined in its bony portion by periosteum,

in its cartilaginous portion by perichondrium, both being covered by mucous membrane. The bones of the pharynx are covered by periosteum, connective tissue, and loosely applied mucous membrane. The mucous membrane of the tube and pharynx, as low as the palate, is furnished with ciliated epithelium, the cilia of which act from the tympanum downwards; ciliated epithelium also covers the mucous membrane of the respiratory portion of the nose. Below the palate-bone the pharynx is supplied with squamous epithelium. The mucous membrane of the Eustachian tube, except its upper wall, is richly filled with acinous and follicular glands, which finally disappear towards the tympanic cavity.

Muscles.—The Eustachian tube is surrounded by structures which influence its action decidedly. Beneath the mucous membrane of the pharynx, and upon and within the connective tissue beneath, there are numerous muscles, which contract with every act of swallowing, and thus affect the position of the Eustachian orifice and its patulency.

The tensor palati muscle is the most important one in connection with the Eustachian tube. It arises by a broad, thin, fan-shaped layer of fibres from the scaphoid fossa and spine of the sphenoid bone, and from the anterior lip of the Eustachian cartilage, sometimes uniting with the tensor tympani, and becomes narrower as it passes downward into its tendon. This passes around the hamular process (hook) of the internal pterygoid plate, expands again into a ribbon of fibres, and is inserted into the posterior edge of the horizontal portion of the palate-bone as far as the middle line. Here it mingles its fibres with its fellow of the opposite side, and with the azygos uvular muscles, which extend from the nasal spine and aponeurosis down in the middle line and form the bulk of the uvula.

The levator palati muscle arises from the under surface of the apex of the petrous portion of the temporal bone, and from the adjoining cartilaginous portion of the Eustachian tube; it passes over the upper concave edge of the superior constrictor of the pharynx, goes downward and inward, spreads out its fibres in the posterior part of the soft palate with the fibres of the tensor

palati, and extends to the middle line, mingling with those of its fellow, and of the uvula.

The stylo-pharyngeus is a long, slender muscle, which arises from the styloid process, passes down between the superior and middle constrictor muscles, and, spreading out beneath the mucous membrane of the pharynx, is inserted into the middle constrictor muscle and the upper part of the thyroid cartilage.

The palato-pharyngeus muscle forms the posterior pillar of the fauces; it arises from the fascia and is mingled with the muscles,

FIG. 12.

MUSCLES OF PALATE AND FAUCES (Leidy).—1, Levator palati muscle, left side removed; 2, tensor palati muscle; 3, azygos uvular muscles; 4, Eustachian tube; 5, origin of palato-glossus and palato-pharyngeus muscles; 6, part of superior pharyngeal constrictor muscle; 7, external pterygoid muscle.

which form half of the soft palate and uvula; is perforated by the levator palati, passes outward and downward behind the tonsil, and spreading out is inserted into the posterior border of the thyroid cartilage and the side of the pharynx, amongst the fibres of the middle constrictor muscle.

The superior constrictor muscle of the pharynx, also, has relation with the Eustachian tube. It is a thin, pale, quadrilateral muscle, which arises from the lower half of the internal plate of the pterygoid process and the hook of the sphenoid bone, and from the pterygo-maxillary ligament, and curves backward and upward to join its fellow in the median line and be inserted into

the pharyngeal spine on the basilar process of the occipital bone. The space above, between it and the levator palati and Eustachian tube, is destitute of muscles and filled with fibrous tissue.

The internal pterygoid is said to take its origin by some fibres from the under portion of the cartilage of the Eustachian tube, and this seems probable from sensations produced in the region by contracting strongly the muscles of mastication.

The roof of the pharynx has such a number of large follicular and racemose glands, surrounded by spongy tissue so much like that of the tonsil, that it has been called the pharyngeal tonsil, or tonsilla pharyngea.

The mucous membrane of the pharynx below the level of the palate-bone contains a great many follicular and racemose glands, which are very frequently hypertrophied and in a condition of inflammation; and the whole region of the throat above the larynx is richly supplied with glands, in a thick and quite vascular mucous membrane, loosely attached to the cellular tissue upon the muscles and bones.

The tonsils proper, snugly ensconced between the pillars of the fauces, are compound follicular glands. They each have twelve to fifteen large follicular openings upon the surface, which lead into pouches having smaller follicles opening into them. They move with the superior constrictor and the palato-pharyngeus muscles, and when hypertrophied exercise a pernicious influence upon the pharynx and the orifice of the Eustachian tube.

The Vessels of the Eustachian tube, upper pharynx and associate mucous membranes, muscles and glands are numerous and important.

The external carotid artery supplies the entire region by its numerous branches, which are here enumerated. The lingual gives branches to the soft palate and tonsil. The ascending pharyngeal supplies the constrictor, tensor, and levator muscles; the mucous membrane of the soft palate, pharynx, Eustachian tube, and tympanum; the tonsil and posterior pillar of the fauces. The facial, by its ascending palatine branch, supplies the superior constrictor, tensor palati, levator palati, and internal pterygoid muscles; the mucous membrane of the soft palate, pharynx and Eustachian tube; the tonsil and deep cervical lymphatic glands.

The internal maxillary gives a branch to the tympanum through the Glaserian fissure, a Vidian branch to the Eustachian tube and tympanum, and petrosal branches of the middle meningeal to the tympanum. It supplies the constrictor, levator palati, tensor palati, and pterygoid muscles; the mucous membrane of the nasal fossa, soft and hard palate, pharynx, and Eustachian tube. All these arteries anastomose freely with each other.

The internal carotid gives off, in its canal in the temporal bone, a small branch, which goes through the anterior wall into the tympanum. Lower down it lies in dangerous proximity, beneath and outside of the tonsil.

The veins of the tympanum, as they pass out through the fissures and foramina and along the Eustachian tube, take the same names as the corresponding arteries. Some unite with the middle meningeal of the internal maxillary, which receives the pterygoid, palatine, and others, and passes behind the neck of the jawbone to unite with the temporal vein. The Vidian, petrosal, and muscular branches join the pharyngeal plexus behind the pharynx, which receives branches from the pharynx, soft palate and tonsil, and unites with the internal jugular. The lingual receives branches from the soft palate, pillars of fauces, and tonsil, and goes to join the internal jugular. The facial receives the inferior branch from the plexus around the tonsil and soft palate. All the veins anastomose freely with each other and have no valves.

The lymphatics form a capillary network in the ear and Eustachian tube, escape from its anterior orifice, and unite with a vast system of vessels from the nasal and pharyngeal mucous membranes and the interior of the cranium. These empty into the deep cervical glands, which receive ducts from the superior cervical glands, and extend as a chain along the carotid artery and internal jugular vein, to finally debouch into the right lymphatic duct, thus forming a direct communication between the middle ear and the blood-current of the right subclavian vein. Quite a cluster of glands is situated just beneath the angle of the jaw, which receives ducts from the superficial and deep glands. These are especially prone to engorgement from external disease of the auricle, and from pharyngeal and tonsillar disease.

The Nerves in and about the tympanum are numerous. The facial nerve, in the internal auditory meatus, sends several filaments to the auditory nerve. In the aqueduct of Fallopius it gives off the great petrosal branch, which joins with some sympathetic filaments from the carotid plexus, and a filament from the tympanic branch of the glosso-pharyngeal, takes the name of the Vidian nerve, goes through the canal in the temporal bone, through the *foramen lacerum anterius* and across the top of the pharynx to the sphenopalatine ganglion. This is located near the sphenopalatine foramen, in the sphenomaxillary fossa. The superior maxillary nerve, after its exit from the foramen rotundum, sends two small branches to this ganglion, and it thus receives motor, sympathetic, and sensory fibres. The ganglion sends branches to the levator palati, azygos uvulæ, palatoglossus and palatopharyngeus muscles; to the mucous membrane of the nasal fossæ, soft palate, hard palate, and gums; to the lateral and posterior pharynx, the orifice and canal of the Eustachian tube, and the tonsil.

The facial, in the aqueduct, sends a fibre, the small petrosal nerve, augmented by a filament from the sympathetic branch of the glosso-pharyngeal, through a superficial canal in the temporal bone, and down through a foramen in the spine of the sphenoid to join the otic ganglion, which is situated inside the inferior maxillary nerve, just below the foramen ovale.

The ganglion receives two or three sensitive filaments from the beginning of the auriculo-temporal, motor filaments from the internal pterygoid of the internal maxillary, and sympathetic filaments from the sympathetic plexus upon the middle meningeal artery. It sends one branch to the tensor palati, and one to the tensor tympani muscle.

The facial, in its aqueduct near the pyramid, gives off a branch that penetrates the inner wall of the tympanum and supplies the muscles therein.

The internal maxillary gives off the internal pterygoid nerve, which supplies the internal pterygoid muscle, and some think, also, the tensor palati.

The pneumogastric nerve in the jugular fossa gives off an

auricular branch (Arnold's), which receives a filament from the glosso-pharyngeal, enters the temporal bone near the styloid process, and joins the facial in the aqueduct. Just below the jugular fossa, the pharyngeal branch leaves the facial. It receives a filament from the spinal accessory, and, at the border of the middle constrictor muscle, unites with the glosso-pharyngeal, superior laryngeal, and sympathetic to form the pharyngeal plexus. This plexus sends branches to the levator palati, palato-pharyngeus, and constrictor muscles, and to the mucous membrane of the pharynx. By other portions of the pneumogastric, communication is made with the œsophagus, larynx, etc.

The glosso-pharyngeal nerve from its petrous ganglion sends a nerve filament to the trunk of the pneumogastric; it gives off the auricular, to unite with a fibre from the pneumogastric, and this joins the posterior auricular of the facial before mentioned. A fine branch anastomoses with the superior cervical ganglion of the sympathetic.

Another branch (Jacobson's) traverses a canal in the temporal bone between the carotid canal and the jugular fossa, enters the tympanum by a foramen in the floor near the inner wall, and divides into several branches which supply the tympanum and contiguous parts.

The pharyngeal branches of the glosso-pharyngeal leave the trunk lower down. They are three or four filaments, that join with branches of the pneumogastric and sympathetic to form the pharyngeal plexus. This is distributed to the mucous membrane of the pharynx and larynx, and to the stylo-pharyngeus, salpingo-pharyngeus and constrictor muscles. Other filaments are distributed to the tonsil, fauces, soft palate, and tongue.

The Internal Ear, the most important portion of the auditory apparatus, includes the labyrinth, the internal auditory nerve, and the internal auditory meatus. It is situated deep within the temporal bone, and extends a little farther back than the tympanic cavity. The bony labyrinth is separate and merely surrounded by the temporal bone in the infant, but it becomes united solidly with it in later years.

There are two distinct parts: one composed of bone, called the

bony labyrinth; and the other of membrane, called the membranous labyrinth.

The bony labyrinth has three divisions: the vestibule, the semicircular canals, and the cochlea.

The name labyrinth is frequently used by authors to signify only the vestibule and semicircular canals.

The Vestibule is situated between the tympanum and internal auditory meatus; its bony wall is thin, and it lies imbedded in the petrous bone.

The semicircular canals are situated posterior and external, and the cochlea anterior and internal to it. It is oval in perpendicular section; pear-shaped with small end forward in horizontal section. It is about 5 mm. long and deep, and 3 to 4 mm. wide. Its outer wall is the inner wall of the tympanum, and contains, as before mentioned, the oval window, or *fenestra ovalis*, closed by the membrane and base of the stapes.

Just behind this is the ampullar opening of the horizontal semicircular canal. Above it is the termination of a ridge of bone from the inner wall and roof, called the pyramis vestibuli of the crista vestibuli. There are several minute openings in this for the passage of nerves, and these constitute the superior macula cribrosa.

The floor of the cavity is a mere groove with a few small foramina for vessels.

The anterior wall has little surface and shows the oval opening of the scala vestibuli, or canal of the cochlea.

The posterior wall has considerable surface and several openings. In the centre is the unexpanded opening of the horizontal semicircular canal. At the junction of the superior, posterior, and inner walls is the straight opening common to the superior and posterior semicircular canals. The ampullar end of the posterior semicircular canal is at the junction of the inferior, posterior, and inner walls. The ampullar end of the superior semicircular canal opens in the roof just behind the crista vestibuli.

The crista vestibuli is a slight ridge of bone, which begins on the outer wall above the oval window, goes across the roof and down the inner wall, and separates into two limbs near the floor

of the vestibule, one curving forwards and one backwards. The inner wall is divided by the crista vestibuli into an anterior portion slightly concave, called the recessus sphericus, and a posterior upper portion, also somewhat depressed, called the recessus ellipticus, bounded below by a slight groove, the sinus sulciformis. Just below and behind this latter is a foramen, the aquæductus vestibuli, through which the vestibular vein goes backward and inward through the bone, along with the funnel from the dura mater, which contains cerebro-spinal fluid.

The space between the limbs of the crista is called the recessus cochlearis. In this, near the upper part, are several foramina, called the macula cribrosa (inferior).

In the anterior inferior part of the recessus sphericus is the macula cribrosa media. Above and behind the recessus ellipticus, near the ampullar entrance of the posterior semicircular canal, is another group of foramina, the macula cribrosa posterior. The macula cribrosa superior is at the termination of the crista upon the external wall.

These foramina all communicate with the internal auditory meatus, and receive filaments from the internal auditory nerve.

The walls of the vestibule are so called for convenience. It is not correct to speak of the different walls of a cavity made by spherical surfaces.

The ridge, described as projecting from two and part of the third wall, constricts the cavity around the middle like a belt around the waist, and thus makes a hemispherical space anterior, and a semi-elliptical space posterior. The anterior contains the sacculus rotundus, and the posterior the utriculus.

The Semicircular Canals are bony, oval tubes of unequal length, irregularly curved more than a half circle, so that their openings come nearly together. They are named according to their position, the superior, the posterior, and the inferior, or horizontal. They are situated above the inner back part of the tympanum, behind and a little outside of the vestibule, with which they communicate by five orifices. Two of these terminate in straight tubes, and three have ampullar dilatations. The latter have been called ampullæ from their fancied resemblance to a wide-mouthed jug.

The posterior semicircular canal is 22 mm., the superior 20

mm., and the horizontal 15 mm. in length. Their general diameters vary from 1 to 1.7 mm., but the ampullæ have a diameter of about 2.5 mm.

The canals are of thin bone, strengthened by fibrous tissue, and much contorted. If a cube be placed just behind the vestibule, approximately, the horizontal semicircular canal would lie flat beneath the lower, the superior upon the inner, and the posterior upon the posterior surfaces of it respectively.

The superior canal is vertical in position, at right angles to the other canals, and makes a rounded prominence on the anterior surface of the petrous bone. Its ampulla opens in the roof,

FIG. 13.

FIG. 14.

FIG. 13.—THE LABYRINTH EXPOSED (Leidy).—1, Vestibular branch of auditory nerve; 2, branch to the sacculus; 3, branch to the utriculus; 4, branch to the ampulla of the posterior canal; 5, branch to the ampulla of the horizontal canal; 6, branch to the ampulla of the superior canal; 7, cochlear nerve; 8, cochlea showing scala, modiolus, etc.

FIG. 14.—THE NERVES OF THE VESTIBULE AND AMPULLÆ ($\times 3$ diam.), (Leidy).—1, Branch to vestibule; 2, branch to sacculus; 3, branch to utriculus; 4, branch to the posterior ampulla; 5, branch to horizontal ampulla; 6, branch to superior ampulla; 7, branch to the cochlea.

and its other end, after uniting with the undilated end of the posterior canal, opens by a straight tube 3 mm. long, into the inner posterior part of the vestibule.

The posterior semicircular canal, the longest of the three, is also placed vertically, and extends to the back part of the temporal bone. Its straight end opens in the inner posterior part of the vestibule, in union with the superior canal, as already described, and its ampulla opens at the lower inner part of the posterior wall.

The horizontal canal, the shortest of the three, extends backwards at right angles to the other canals. Its unexpanded limb opens into the vestibule in the middle of the posterior wall, and its ampulla at the upper part of the external and posterior walls.

Thus the three semicircular canals have five openings, two straight unexpanded tubes, and three expanded into the peculiar pear-shaped ampullæ.

The vestibule and semicircular canals are lined throughout by a fibro-serous membrane; the fibrous portion, like a periosteum, adheres closely to the inner surface; it sends a tubular process along the aquæductus vestibuli to the dura mater; it extends into and lines the scalæ of the cochlea, and sends a tubular prolongation along the aquæductus cochleæ to the dura mater.

The serous surface consists of a basement membrane covered by tessellated epithelium. The fibro-serous membrane passes over the membranes of the round and oval windows. It secretes a bland, watery fluid, called the perilymph (*aqua labyrinthi*, or *liquor Cotunnii*), because it surrounds the membranous labyrinth. It is said to be received in some measure from the subarachnoid space through the foramen acustica, and to escape when in excess through the aquæductus cochleæ. The perilymph is a weak alkaline fluid, containing a little albumen. This fluid surrounds the membranous semicircular canals and the saccules, and is continuous through the oval opening in the anterior wall of the vestibule with that which fills the vestibular and tympanic scalæ of the cochlea.

The bony labyrinth incloses the membranous labyrinth, which consists of a sac constricted in the middle into two pouches, and of three canals communicating with it. These are counterparts in shape of the bony labyrinth, but are a little smaller. They do not float freely in the perilymph, because numerous vessels, nerves, lymphatics and fibrous bands hold them rather near to the osseous labyrinth. The fibrous bands have been called *ligamenta labyrinthi canaliculorum*. The vestibular portion is closer to the inner wall of the cavity, and is removed a little distance from the outer wall, so that it does not interfere with the oval window. The membranous ampullæ lie close to the bony wall, but other parts of the labyrinth are more removed.

The portion of the membranous labyrinth contained in the vestibule is constricted in the middle. The anterior lower portion is of globular form, is called the sacculus rotundus, and occupies the recessus sphæricus (fovea hemispherica). The posterior and upper portion is elliptical in shape, is called the utriculus, and occupies the recessus ellipticus (fovea semielliptica). This shows the five openings of the tubes and ampullæ of the membranous semicircular canals, which occupy the bony semicircular canals, being held in position by ligaments at their convex portions.

The membranous labyrinth is composed of several layers. The fibrous layer is a dense membrane showing connective tissue cells and nuclei. It is the thickest and most important layer, furnishing a firm support for the delicate structures within, for the attachment of external ligaments, and the passage of nerves and vessels. Next to this layer upon its inner surface there is a network that is supposed to consist of nerves and ganglia. The hyaloid layer, or tunica propria, covers this, and is closely united with the fibrous layer. It resembles the hyaloid membrane of the eye, but upon close examination shows longitudinal fibrillation and elongated nuclei.

Upon the inner surface of the hyaloid layer of the semicircular canals are found various sized papillary prominences, or minute elevations, which are most numerous near the middle portion of each arc, and do not extend into the utriculus. Over these and upon the whole internal surface of the canals, there is a layer of thick, nucleated pavement epithelium, which terminates at the ampullæ, where ciliated epithelium is found.

The vestibule, or saccules, and the ampullæ are covered by a thin, yellowish ciliated epithelium. The hyaloid layer is thickened where it extends into the ampullæ, and the short ciliated ridge is called the *crista acustica*. There is a similar projection of ciliated cells in the saccules, called the *macula acustica*. At the end of each *crista acustica* an elevation of ciliated epithelium, called the *planum semilunare*, extends along each ampulla.

Filaments of the auditory nerve from the network mentioned above extend into the cilia of these parts, and receive impressions from the vibrating lymph and dancing otoliths.

Otoliths, otoconia, or ear stones, are composed of single and aggregated crystals of carbonate of lime of different sizes and angular shapes, which are found within the membranous labyrinth. The minute ones are unattached here and there, and some writers state that they are found exceptionally in the semicircular canals and cochlea. There are two large, white, discoid masses of otoliths, having a fibrous, cartilaginous, or amorphous organic mesh, that holds the crystals together; these adhere to the epithelium, one in the utricle and the other in the saccule, near the cribriform spots, where the nerve filaments terminate in great numbers.

That otoliths serve an important purpose in audition is evident from the fact, that they exist in the ears of many of the lower animals having excellent hearing.

FIG. 15.

HUMAN OTOLITHS FROM THE VESTIBULE.

The membranous labyrinth is completely filled with a limpid serous fluid, alkaline and albuminous, called the endolymph (liquor Scarpæ). Dr. Hasse states that an epicerebral lymph cavity sends a tubular membrane through the aquæductus vestibuli to communicate with the vestibule, and thus convey cerebro-spinal fluid to act as endolymph, or to relieve excess of endolymph at any unusual increase.

The Cochlea consists of a conical axis of bone, surrounded by a bony canal wound spirally around it in decreasing turns from base to apex, and the whole is massed together and covered by the temporal bone. It takes its name from its resemblance to a snail shell. It forms the anterior portion of the labyrinth, and

is situated almost horizontally, anterior to the vestibule. Its base is at the posterior, inner surface of the temporal bone, and its apex is directed outward, downward, and a little forward, coming near the upper anterior part of the inner wall of the tympanum.

The axis, modiolus, or columella is a solid, acute, cone-shaped pyramid of bone perforated by five canals for the passage of vessels and nerves. Its length is $2\frac{1}{2}$ mm.; the diameter of its base is 2 mm., and its apex $\frac{1}{2}$ mm.

The spiral, or cochlear canal is a bony tube that winds closely around the axis from base to apex, and is divided by bone and membrane into three canals; they are the vestibular scala, the tympanic scala, and the cochlear duct. The lower end of the tube begins between the tympanic and vestibular openings of the cochlea, at the outer lower corner of the vestibule, reaches the modiolus, and winds forwards and upwards, in the right ear from right to left, and in the left ear in a reverse direction, two and a half times around it. Each turn of the canal diminishes in

FIG. 16.

THE COCHLEA UNROOFED (Leidy).—1, Osseous wall of the cochlea; 2, lamina spiralis ossea, above; 3, end of the osseous lamina; 4, 5, edge of the osseous lamina; 6, lamina spiralis membranacea; 7, end of the membranous lamina; 8, helicotrema, and passage to the scala tympani.

diameter towards the apex, and it terminates by a closed extremity called the cupola, which lies near the front surface of the temporal bone, close to the canal of the tensor tympani muscle, and above the ascending part of the carotid canal. The first turn of the canal is near the surface of the inner tympanic wall, and makes a projection known as the promontory. The canal is 28

mm. long, and its greatest diameter 1 mm., and its last half turn diminishes gradually in calibre. The cochlea proper has a base 4 or 5 mm. in diameter, and its height is about the same.

The canal in the bone varies in the shape of its transverse section. At some places, it is triangular, with the outer side convex; at others, it is semicircular, and again at others, oval. A thin bony shelf of two united plates projects from the modiolus about half way across the canal, and helps to divide it into two parallel canals, the *scalae*. This is the spiral lamina, or *lamina spiralis ossea*; it is 1.2 mm. wide and .3 mm. thick at the lower end, and .5 mm. wide and .15 mm. thick at the upper end.

FIG. 17.

THE COCHLEAR NERVE (Leidy).—1, Trunk of the nerve; 2, *membrana basilaris* with membrane of Reissner removed; 3, filaments of the nerve passing from the osseous lamina to organ of Corti; 4, *helicotrema* leading to the *scala tympani*.

The lamina begins upon and curves gracefully away from the wall of the vestibule to the modiolus, winds spirally around this, like the threads of a screw, and terminates in the cupola by a sharp crescentic edge or hook, called the hamular process. The undivided space between this and the end of the cochlear canal is called the *infundibulum*, or *helicotrema*. Around the modiolus, in the base of the lamina, passes a canal called the *canalis spiralis modioli*. Between the two surfaces of the lamina are numerous radiating canals for the passage of nerves from the modiolus;

these open upon the side next the base of the cochlea through perforations in the edge, called the *habenula perforata*.

The fibro-serous, periosteal lining of the vestibule is continuous as the *canalis reuniens*, through the oval opening in its anterior wall into the cochlear canal, and is closely attached to its walls and to the lamina spiralis throughout their extent. Near the edge of the lamina spiralis, the membranous layers from its surfaces approach each other. That covering the basal surface of the lamina, called the *membrana basilaris*, runs straight along and across to the opposite wall of the canal, where it is firmly attached to the bone. The place of attachment is thicker than elsewhere, owing to an extra development of connective tissue, and has been called the *ligamentum spirale* of Henlé. This membrane completes the partition between the tympanic scala and the cochlear duct, but ends at the hamular process above, and forms the sharp border of the *helicotrema*. The membrane covering the apical surface of the lamina, the *membrana vestibuli*, becomes thickened by connective tissue and epithelium before it reaches the border of the osseous lamina, then gradually becomes thinner, and finally terminates at the edge of the bone by irregular, cartilage-like, dentate processes, which are collectively named the *lamina denticulata*. The inner edge of these processes is called the *crista spiralis*, and the processes themselves the aural teeth.

The *membrana tectoria*, or delicate roof-membrane, takes its origin here, extends parallel with the *membrana basilaris*, a little separated from it, as far as the beginning of the organ of Corti, where it terminates by a feather edge.

The thickened portion of vestibular membrane behind the dentate processes gives off at an angle of 40° a delicate fibrous membrane, the membrane of Reissner, which goes to be attached to a cushion of connective tissue upon the outer wall of the cochlea, at some distance, of course, above the *membrana basilaris*, thus leaving a space between them, called the ductus cochlearis. This duct is taken from the vestibular scala, lies between it and the tympanic scala, and incloses the organ of Corti. Its outer wall is covered by the fibro-serous lining common to the *scalæ*. The membranes passing from the lamina spiralis ossea to the outer wall of the canal, and dividing it into three canals,

are mentioned collectively in general anatomy as the lamina spiralis membranacea.

FIG. 18.

FIRST COCHLEAR COIL (Burnett) (Transverse section $\times 100$ diameters).—*a*, Vestibular lamella of lamina spiralis ossea; *b*, *c*, origin and attachment of Reissner's membrane, middle portion cut away; *b*, *c*, crista spiralis; *c*, process forming one of the auditory teeth; *d*, membrana tectoria; *f*, *p*, cushion of connective tissue, called the ligamentum spirale of Köl liker; *g*, *o*, periosteum; *h*, *n*, osseous wall of the cochlea; *i*, stria vascularis; *j*, vas prominens and ligamentum accessorium spirale; *k*, sulcus spiralis externus; *l*, ligamentum spirale of Henlé; *m*, periosteum; *n*, bone; *o*, union of connective tissue and periosteum; *q*, *c*, zona denticulata; *q*, *u*, organ of Corti; *q*, *l*, zona pectinata and epithelium above; *r*, region of outer ciliated cells; *r*, *t*, zona arcuata; *s*, thinnest part of membrana basilaris; *t*, region of inner ciliated cells; *u*, habenular perforata, or place of nerve entrances; *u*, *l*, membrana basilaris; *v*, sulcus spiralis internus; *w*, tympanic lamella of lamina spiralis ossea; *x*, cochlear nerve fibres; *y*, ductus cochlearis; *sv*, scala vestibuli; *st*, scala tympani.

The basilar membrane and membrane of Reissner have radiating lines, are covered by epithelium, and have a glassy, transparent appearance. They pass from the osseous spiral lamina to the opposite wall of the cochlear canal, and there become continuous with its fibro-serous lining. The spiral cochlear canal is thus subdivided into the hemispherical tympanic scala below, the imperfect obtuse triangular vestibular scala above, and the triangular cochlear duct between these.

The three spiral canals run parallel to each other from the base to the cupola of the cochlea, where the scalæ communicate by the helicotrema, and the cochlear duct ends at the hamular process in a blind extremity.

The canal below the basal lamina, when the cochlea is placed upon its base, is the scala tympani, or tympanic scala. It is closed at its lower end by the membrane of the round window of the tympanum, the *membrana tympani secundaria* of the *fenestra rotunda*, situated behind and below the promontory. The fibro-serous membrane of the outer wall of the scala passes over the inner surface of this secondary membrane and adds to its thickness.

A little distance from the lower end of this scala, and in its wall, there is a foramen of a canal, the *aquæductus cochleæ*, which passes down through the temporal bone and opens upon its base just inside the carotid canal. It transmits the cochlear vein to the inferior petrosal sinus, or in some cases to the internal jugular. There are several other openings in this part of the scala, through which vessels pass into the canals of the modiolus.

The scala tympani passes by diminishing turns around the modiolus, towards the apex of the cochlea. Its basal wall is the cochlear wall proper, and that towards the apex is the lamina spiralis and membrana basilaris, until it reaches and ends in the infundibulum, or cupola. This is merely the rounded end of the cochlear canal common to both scalæ, as the spiral lamina stops before it reaches the end and thus the two scalæ are no farther divided.

The space between the termination of the membranous spiral lamina and the cul-de-sac of the cupola may be regarded as the beginning of the vestibular scala. The base of the scala is made by the vestibular lamella of the spiral lamina, and by the mem-

brane of Reissner, and its roof by the wall of the cochlear canal proper. The scala passes by increasing turns around the modiolus parallel to its companion towards the base, and opens directly into the vestibule by an oval opening in its anterior wall, and is hence called the scala vestibuli, vestibular scala.

The fibro-serous membrane lining the scalæ is periosteal in character, covered by pavement and peculiar epithelium, continuous with that of the vestibule.

The scalæ are filled by perilymph, which flows freely from the vestibule through the oval opening along the vestibular scala to the helicotrema, and then passing downwards over the hamular process and sickle-shaped edge of the dividing membrane in the cupola, goes backwards along the turns of the tympanic scala to the inner surface of the membrane of the round window of the middle ear.

The triangular ductus cochlearis has its base formed by the membrana tectoria and membrana basilaris, its outer wall by the cochlear wall proper, and its roof by the membrane of Reissner. It diminishes the space that would otherwise be in the scala vestibuli. It follows a spiral course between the scalæ, and is closed at both ends. It is lined by pavement epithelium and filled by a fluid similar to the perilymph.

The outer wall of the duct has a vessel passing along it called the *vas prominens*, and between this and the external attachment of Reissner's membrane is found the *striæ vascularis*. The surface or floor of the duct has near the edge of the bone a longitudinal space, the *sulcus spiralis internus*, or internal spiral groove; at the outer attachment of the membrana basilaris there is another longitudinal space, the *sulcus spiralis externus*, or the external spiral groove. It is further divided into three zones. From the crista spiralis to the outer end of Corti's organ is called the *zona denticulata*, from the inner to the outer ciliated cells, included in the former zone, is the *zona arcuata*, and from the outer border of the organ of Corti to the *sulcus spiralis externus* is the *zona pectinata*. These names are slightly descriptive of the appearance of the parts.

The Organ of Corti is a peculiar ridge of connective tissue, nucleated and ciliated cells, granular matter, and nerve filaments,

situated upon the membrana basilaris within the ductus cochlearis, between the edge of the lamina spiralis ossea and a line midway between it and the outer wall of the duct. It was first described by the Marquis of Corti, but our knowledge of it has been greatly increased by later studies with the microscope.

FIG. 19.

THE ORGAN OF CORTI (Burnett) (Transverse section $\times 800$ diam.).—*a*, Columnar epithelium in the sulcus spiralis internus; *b*, entrance of cochlear nerve; *c*, basilar process of *d*, with granular matter about the nerve filaments; *d*, inner ciliated cell; *e*, head of an inner pillar and location of cilia of inner ciliated cells; *f*, summit of the arch formed by union of the inner and outer pillars, the upper portion of one and the whole of another outer pillar ending above *g*; *g*, *i*, *j*, outer ciliated cells; *h*, a branch from *g*; *k*, membrana reticularis extending to *e*; *l*, one of the support cells with base cut away; *m*, bases of two more outer ciliated cells; *n*, vestibular layer of the membrana basilaris in the zona pectinata; *o*, *y*, homogeneous layer of membrana basilaris; *p*, transverse section of connective tissue fibrillæ, nuclei, and granular protoplasm in membrane of scala tympani; *r*, vas spirale; *s*, nerve filament extending across the arch of Corti from the cochlear bundle to an outer ciliated nerve; *t*, base and granular protoplasm of an inner pillar; *u*, thick origin of the membrana basilaris; *v*, blood-vessels; *w*, periosteum of lamina spiralis ossea; *x*, a fasciculus of the cochlear nerve within the bone; *y*, tympanic lip of the crista spiralis.

The surface of the membrana vestibuli, upon the edge of the bony lamina spiralis within the ductus, is covered by a layer of large, plump, columnar epithelial cells arranged vertically. The inner ciliated cells stand next to these outwards; they consist of a single row of long large cells, with strong cilia in tufts above,

and their lower ends terminating in a granular layer of indeterminate structure. The inner pillars come next. They are a row of still longer nucleated, non-ciliated cells, having their large bases fixed upon the membrana basilaris, and their upper ends, or heads massed with other cells from without, and with the membranous layer upon them. A triangular space, following the spiral direction of the duct, succeeds these, and is limited outwards by a second row of long nucleated cells, the outer pillars.

The outer pillars rest upon the membrana basilaris, curve inward towards the spiral lamina, and their broad head-pieces fit into a depression between the heads and head-plates of the inner pillars, forming with these the pillars and arches of Corti.

The inner and outer row of pillars and the membrana basilaris thus form a triangular tube, which runs the whole length of the ductus cochlearis, and makes a fourth duct in the cochlea.

There are said to be three thousand of these pillars; the height of the triangle which they form increases towards the hamulus.

The outer ciliated cells stand next to the outer pillars and parallel with them. They consist of five rows of large ciliated cells, arranged close together in rows. Their bases rest upon the membrana basilaris, and their ciliated ends are held in the roof of the organ, adjoining the heads of the external pillars. Outside of these is still another row of cells parallel to these, but non-ciliated, and called support cells.

The membrana reticularis is a netlike layer of connective tissue, which extends from the place where the two sets of pillars are joined together to the row of support cells, and covers over the intervening structures. The tufts of cilia of all the outer ciliated cells fit into and project through these meshes, and are bathed by the fluid of the ductus cochlearis. The parts of this membrane around the ciliated ends are called rings, and the spaces between, phalanges.

The membrana tectoria is over the membrana reticularis and ciliated tufts, in light contact with them, and terminates in a thin free edge as far outward as the support cells.

The ultimate fibres of the cochlear nerve pass out of the foramina in the lamina spiralis ossea, are distributed to the inner

and outer ciliated cells, and lost in their granular matter and nuclei. Their number is estimated at 16,400 filaments.

The organ of Corti consists simply of rows of ciliated cells, supplied by filaments from the cochlear nerve, and protected and held in proper relationship by membranes and bone.

FIG. 20.

CAST OF LEFT LABYRINTH (Burnett).—*a*, Fenestra ovalis; *b*, ampulla of superior semicircular canal; *c*, ampulla of horizontal semicircular canal; *d*, straight canal, formed by union of superior and posterior canals; *e*, ampulla of posterior semicircular canal; *f*, fenestra rotunda; *g*, tractus spiralis foraminosus.

The Internal Auditory Meatus is situated in the posterior surface of the inner third of the petrous portion of the temporal bone, near its upper edge, and directly over the jugular foramen (fossa). It is a funnel-shaped opening looking directly inward, and towards its fellow opposite, so that a straw passing from one to the other would be about 12 mm. behind the basilar process of the occipital bone, and 18 mm. above the anterior border of the foramen magnum. The funnel-shaped meatus leads into a cylindroid canal about 3 mm. in diameter, and 18 mm. in length, which leads downward, forward, and outward to the inner wall of the labyrinth; this bottom, or cul-de-sac, is divided by a transverse crescentic ridge into a small upper and a large lower portion. The upper part is subdivided by a vertical ridge into two pits. The anterior one leads into a canal in the bone, the aquæductus Fallopii, which is directed forward, then turns sharply backward and outward above the vestibule, and curves downward in the inner and posterior wall of the tympanum, to open upon the base of the skull just behind the styloid process, as the stylo-mastoid foramen. This devious canal transmits the facial nerve, or portio

dura of the seventh pair of nerves, and some of its branches through the temporal bone.

The posterior pit of the upper division contains numerous foramina of canals, which pass into the vestibule, forming near the spine of the crista vestibuli the superior cribriform spot; they transmit the superior branch of the vestibular nerve, and some vessels.

The lower and larger portion of the bottom of the canal, below the transverse septum, at its anterior (inner) side, is occupied by the base of the modiolus, and the beginning of the spiral tract. It is perforated by minute foramina of canals, which pass into the modiolus; some follow the lamina spiralis ossea around the axis; others bend out from the axis at different heights, penetrate between the plates of the lamina, and open in the perforated place called the habenula.

These canals transmit the cochlear nerve and vessels to the bony and membranous structures of the cochlea.

One canal in the cul-de-sac passes through the wall of the vestibule into the upper part of the recessus cochlearis, and forms a lesser cribriform spot, through which a filament of the cochlear nerve goes to the septum of the sacculus in the vestibule.

The posterior (outer) portion of the lower division is perforated by foramina of canals, which pass into the vestibule in the recessus sphaericus, and form the middle cribriform spot for the middle (inferior) division of the vestibular nerve.

In the posterior wall of the canal, there is a foramen of a small canal, which opens by several foramina in the ampulla of the posterior semicircular canal, and forms the inferior cribriform spot. The posterior division of the vestibular nerve passes by this means to its distribution.

A tubular process of the dura mater, inclosing the facial and auditory nerves, goes to the bottom of the internal auditory canal, and is prolonged into the aquæductus Fallopii, for the passage of lymph, and to supply the vestibule with perilymph.

About 6 mm. outside of the internal meatus there is a slitlike depression in the temporal bone, at the bottom of which is the opening of the aquæductus vestibuli, which leads into the vestibule.

Vessels.—The internal auditory artery, a branch of the basilar, accompanies the auditory nerve to the bottom of the internal auditory canal, where it divides into the vestibular and cochlear branches. The vestibular vessel divides into several branches, which pass through numerous foramina and the inner wall of the vestibule, and are distributed in a fine capillary network to the bone, sacculus, utricle, and semicircular canals.

The cochlear vessel, also, immediately divides into about a dozen branches, which enter the foramina in the base of the modiolus and tractus spiralis, mingle with the nerve filaments, and proceed towards the apex of the cochlea, giving off branches, which bend outward in the lamina spiralis ossea, and supply the bone, the lamina spiralis membranacea, and all the soft tissues. Anastomoses exist between the capillary bloodvessels of the internal and middle ear, so that disease may pass from one part to the other.

The veins of the labyrinth are exceedingly irregular. The venous radicles of the soft structures of the vestibule and semicircular canals mostly unite in one trunk, the vestibular vein, which passes out of the petrous bone through the aquæductus vestibuli, and empties into the superior petrosal sinus. A tubular process of membrane from the sacculus, and another from the utricle unite and form a single membranous canal, which accompanies the vestibular vein, and is said to terminate in a blind extremity, or *cul-de-sac*, within the dura mater. Some authors consider this an open process of the dura mater to the vestibule, through which the cerebro-spinal fluid flows freely in and out of the vestibule from the base of the brain.

A few venous radicles from the vestibule pass through its walls into the base of the cochlea, and join the venous sinus in the spiral canal of the modiolus. Part of the venous radicles of the soft tissues of the cochlea enter the lamina spiralis ossea through the foramina upon its surfaces and in the habenular, and form the spiral venous sinus, which receives the branches from the vestibule, escapes from the base of the cochlea into the internal auditory canal, and, passing out of its meatus, joins the inferior petrosal sinus. A few other radicles from the soft tissues of the cochlea form a trunk, which passes out of the tympanic scala

through the aquæductus cochleæ, escapes from the little triangular pit upon the base of the skull in front of the jugular foramen, and joins the inferior petrosal sinus, or the jugular. A tubular membrane accompanies this vessel from the tympanic scala to the base of the skull, and is said to furnish an outlet for the lymph of the cochlear canal.

Thus the vestibule and cochlea have each two sets of efferent vessels, so that, should one set be obstructed, the other would probably be able to carry off the venous blood.

Lymph spaces and lymphatics have been demonstrated in the internal ear. A tubular process of the dura mater passes through the aquæductus vestibuli and divides into two branches; one communicates with the utriculus, and the other with the sacculus, as before described; so that the cerebro-spinal fluid can ebb and flow from the surface of the brain to the cavity of the vestibule. A tubular membrane is prolonged from the dura mater into the curved portion of the aquæductus Fallopii, which is probably a lymph space of like character. The dura mater lines the internal auditory meatus, and is continuous with the periosteal lining of the foramina in the bottom, and with that serous modification which covers the walls of the labyrinth, so that the cerebro-spinal fluid can flow into the internal auditory canal and the labyrinth, helping to supply the perilymph, which surrounds the saccules and semicircular canals, and fills the scalæ of the cochlea. From the lower end of the scala tympani, a tubular process of membrane leads downwards through the aquæductus cochleæ to the base of the skull, in front of the jugular foramen, and thus furnishes a channel of escape for an overflow of lymph.

The discovery of perivascular lymph spaces around the cerebral vessels, renders it probable that they extend into the internal ear with its bloodvessels; and the lymphatics found in the pia mater seem to indicate that the internal ear is well supplied with them, though few have been yet demonstrated with certainty.

Nerves.—The facial nerve arises by a small root from the gray nucleus in the floor of the fourth ventricle in the medulla; it passes outward between the restiform and olivary bodies, and unites with a larger root from the restiform body. It crosses the medulla upon the upper side of the auditory nerve, lying in

a depression, goes horizontally in a double sheath with the auditory to the internal auditory meatus, where it is anterior to its fellow, and, at the bottom of the canal, gets above it.

A few nerve filaments connect the nerves in the canal; the facial now passes through the foramen in the anterior pit of the superior division of the bottom of the canal, and bends backward along the course of the aquæductus Fallopii. Just here it is increased in size by the addition of several nervous ganglia, which form a reddish swelling that is called the *intumescencia gangli-formis*. This part of the nerve gives the large petrosal nerve to the sphenopalatine ganglion, and the small petrosal to the otic ganglion, and receives the external or superficial petrosal, a sympathetic branch from the sympathetic plexus of the great meningeal artery.

The facial nerve now passes backward, and follows its course down behind the tympanum. When it gets opposite the pyramid of the middle ear, it gives off a fibre that enters the tympanum through a foramen in its posterior wall, and divides into two branches, which are distributed to the stapedius and the laxator tympani muscles. This fibre is sometimes called the tympanic nerve.

About 6 mm. above the stylo-mastoid foramen, the facial gives off the chorda tympani nerve, which passes upward in a separate canal parallel with the facial aqueduct, enters the tympanum through a foramen in the posterior wall, near the lower outer corner, and passes across the tympanic membrane, and out through the canal of Huguier. The external branches of the facial have already been considered.

The internal auditory nerve arises by one root from the transverse white striæ in the floor of the fourth ventricle, and from the gray matter of the medulla, and by another root from a gray nucleus in the crus cerebelli and the restiform body; this latter has a small ganglion upon it. The fibres unite, and the nerve passes outward between the restiform and olivary bodies, in the same groove with the facial, but just below it; the two nerves are separated here by a small artery of the bulb. The two nerves soon come together, the facial resting in a groove upon the auditory, and pass in a double sheath nearly horizontally to

enter the internal auditory meatus, where the auditory gets external (posterior) to the facial.

The auditory nerve has a very thin neurilemma, and is soft and gray. It divides at the bottom of the canal into the cochlear and vestibular nerves.

The vestibular nerve presents a small ganglion upon its root, and then divides into three branches: *a*, a superior branch, the filaments of which pass through the superior group of foramina, behind the entrance of the aquæductus Fallopii, and enter the vestibule through the superior cribriform spot, to be distributed to the utricle and the membranous ampullæ of the superior and horizontal semicircular canals; *b*, a middle branch (inferior), which sends its filaments through the posterior group of foramina below, and through the middle cribriform spot to supply the sacculus; *c*, an inferior branch (posterior), whose filaments enter the foramina in the posterior wall of the canal, escape from the inferior cribriform spot and are distributed to the membranous ampulla of the posterior semicircular canal. The terminations of these nerve filaments in the membranes have been already described. The nerves float in the perilymph in their passage from the bone to their distribution in the membranes, and their ends are soaked in the endolymph, which washes the epithelium within.

The cochlear nerve, at the bottom of the canal, gives off a small branch, which enters a foramen, passes through the wall of the vestibule, and escapes at the lesser cribriform spot, to supply the membranous septum between the utricle and sacculus. The main portion of the nerve enters the base of the modiolus and lamina spiralis ossea, and continues in canals around and through the axis to the hamular process, distributing filaments in a radiating manner outward, between the bony plates of the lamina spiralis ossea and through the habenula perforata, to pass into the ductus cochlearis and the organ of Corti.

These fibres form a gangliated plexus just before passing out of the lamina spiralis, and are divided into an inner fasciculus for the inner ciliated cells of the organ, and an outer fasciculus for the outer cells. They pass from the habenula through the granular layer, then each filament goes into the interior of its cell, and the soft axis cylinder mingles its neural elements with the nucleus and protoplasm.

Sympathetic nerve fibres from the superior cervical ganglion accompany the vessels into the vestibular and cochlear structures, and regulate the blood-supply.

The cerebral surface of the petrous portion of the temporal bone is covered closely by the dura mater, and the tough fibres of the tentorium are firmly attached to its upper edge.

The superior and inferior petrosal sinuses skirt the edge of the posterior surface above and below, and join the lateral sinus,

FIG. 21.

THE RIGHT EAR DISPLAYED (Leidy).—1, Auricle; 2, concha; 3, 4, external auditory canal and meatus; 5, ceruminous gland; 6, membrana tympani; 7, incus; 8, malleus; 9, manubrium of malleus; 10, tensor tympani muscle; 11, tympanum; 12, Eustachian tube; 13, superior semicircular canal; 14, posterior semicircular canal; 15, horizontal semicircular canal; 16, cochlea; 17, internal auditory meatus and canal; 18, facial nerve; 19, large petrosal nerve; 20, 21, aquæductus Fallopii.

which curves deeply towards the mastoid, and then goes inward and downward to the jugular vein. The close proximity of these large vessels to the ear and mastoid must be remembered, in order to appreciate the danger of disease in those parts.

The middle lobe of the brain rests in front upon the petrous portion of the temporal bone; the posterior lobe is behind it,

resting upon the tentorium, and the lobe of the cerebellum below and behind fills the posterior fossa, and is snugly covered over by the tentorium.

The Infant's Ear differs considerably from that of the adult which has just been considered, and it is important to the aurist to know what these differences are. The younger the person is, the more cartilage there is in place of osseous structure, and the less developed are the cavities, tubes, and processes of the temporal bone. The tympanum is filled at birth by a gelatinous substance, which is said to disappear within the first twenty-four hours of life, and its absence is considered medico-legal evidence of live birth.

The bony portion of the external auditory canal is short; the passage from the external auditory meatus to the pharyngeal end of the Eustachian tube is nearly a straight transverse line, and the membrana tympani is so oblique from above, inward, and forward, as to serve almost as a prolongation of the anterior superior wall of the canal. The tympanum lies much nearer the surface of the side of the head than in the adult, and the flakes of bone and cartilage that surround the ear, the mastoid, and the external canal are very thin and delicate and easily perforated.

The mastoid process consists of a group of small cells with their long diameters antero-posterior, situated immediately behind the tympanum and the auditory canal, and extending a little above and below the walls of the latter. They are limited externally by the squamous portion of the temporal bone, anteriorly by the posterior wall of the auditory canal, and superiorly by a prolongation of the thin scale of bone that forms the tympanic roof. The lower cells are a little below the level of the tympanum, and secretions are apt to collect in them and excite inflammation. This anatomical arrangement favors the development of caries, which is prone to excite cerebral irritation and disease by transmission upwards through the delicate tympanic roof. The great mastoid of adults is developed behind and below this portion, and is more liable in case of caries to affect the lateral sinus and the cerebellum.

The ears of infants and children should be examined with extreme care, as serious results may follow rough or unskilful manipulation.

CHAPTER II.

PHYSIOLOGY OF THE EAR.

THE auditory apparatus in man is exquisitely adapted, like all things in nature, to the forces which act upon it. A funnel-shaped external part concentrates waves of sound, and conducts them to a vibratory membrane; this membrane transmits its vibrations by delicately adjusted osseous levers to another membrane, attached to the inner end of the chain of ossicles; these corresponding vibrations, like echoes of the first, set in motion fluid contained in a bony cavity beyond the membrane, which surrounds closed sacs, containing fluid, and having nerve terminations projecting in epithelium upon their inner surfaces. The fluid within the bone in front of the sacs moves by gentle waves up one spiral tube in the cochlea and down the other, setting thousands of attuned keys that lie in the membranes between them into quavers, and beats and breaks like mimic surf against the second membrane of the internal ear, to exhaust its force, and to counteract other vibrations that come from the first membrane across the tympanum independent of the chain of bones, and thus to smother, after proper record, all the tones of sound.

Delicately and correctly shaped auricles are a thing of beauty, and an attribute of culture and taste. Long, thin, coarse, thick, or misshapen ears generally accompany faulty development in other parts of the body, and are seen in the simple, the ignorant, and boorish. The position upon the head, whether close down or standing far out, has much to do with the impression they produce upon the observer. I have seen them stand out so far that the auricle was in a direction parallel with the face, and again so flattened as to be barely visible from in front.

The auricle is rarely movable at will in man. The muscles attached to the auricle, both extrinsic and intrinsic, are analogous to very useful ones in the lower animals. Whether civilization

has caused their partial atrophy in the *genus homo*, I leave lovers of speculative philosophy to determine.

Man must turn his head instead of his ears to catch the direction and character of slight sounds. The extrinsic muscles act involuntarily to a slight degree in all persons upon the application of a stimulus, such as an ear douche, or a passage of the electric current. The pinna is drawn upward and forward, and upon the stimulus ceasing, it goes back to its proper position. I have occasionally seen persons move the pinna voluntarily, and it always went upward strongly, a little forward, and then back to its position. It is probable that among the savage and coarsely developed races of men the muscles of the auricle may be so large, as to enable a voluntary movement of the pinna, shaping and directing its concavity towards the source of sound.

The cartilage of the auricle gives it shape and character, and the auricle as a whole acts as a resonator of sound. Dr. Burnett says, "the region of the helix and its fossa resound to the deeper notes, the antihelix and its fossa to the intermediate notes, and the concha to the high partial tones." If the relations or shapes of the different parts of the auricle are altered artificially, or by disease, the action of the organ is modified. He continues, "the auricle, in combination with the *meatus auditorius*, forms a resonator of a more or less conical shape, closed at the bottom by the *membrana tympani*, the special function of which is to strengthen by resonance those waves of sound which possess a short wave length."*

The length of high note waves corresponds closely with the length of the meatus and canal, and of lower note waves with this length augmented by the depth from the border of the meatus to the outer edge of the helix. This depth of ear is increased and the vibrations condensed by pulling the auricle outward, by holding the hand around the auricle, and by the use of a trumpet; thus the natural resonance is greatly increased by those who are deaf or who wish to catch feeble sounds.

* The Ear, Its Anatomy, Physiology, and Diseases. By C. H. Burnett, A.M., M.D. H. C. Lea, Philadelphia, 1877. This is a standard work, to which I am indebted for many facts and some excellent illustrations embodied in my book, and I recommend it to all who desire an elaborate treatise.

The hairs often seen about the mouth of the meatus serve to shield the canal from dust, and the cerumen always found in a limited amount in healthy ears lubricates the skin and protects the deeper parts from dirt, moisture, and rude winds. This dries and falls out usually, if let alone, as the canal from the place of its secretion slopes downward and outward, and the epithelium of the canal is supposed to move outward during its growth.

The auditory canal is the small part of the auricular trumpet, and it aids in the condensation of sound as above described.

The *membrana tympani* receives the vibrations of sound directed against it by the external ear and canal.

Sound is an impression produced upon the auditory nerve by the vibrations of sonorous bodies. The atmospheric air is usually the medium of transmission for the vibrations, or waves of sound. Noise is a sensation produced by waves of unequal length; music is one produced by those of equal length. All sounds have the same velocity in the same medium, but no sound is transmitted in a vacuum. Sound moves in the air at a temperature of 61° F. at the rate of 1118 feet per second. As the temperature is lowered, the velocity diminishes a foot and a tenth for every degree. The velocity of sound in liquid is increased over that in air about four and a half times, and in solids from four to sixteen times.

Sound has three qualities:

1. Tone, or pitch, is high or low; the more rapid the vibrations, the higher will be the sound.

2. Intensity, or loudness, depends upon the height of the vibrations; sounds may be of the same tone, but of different degrees of loudness.

3. Quality is a peculiarity in sound by which one can distinguish between two sounds having the same tone and intensity. For instance, everybody can tell the notes of the flute from those of the clarionet.

The number of vibrations, or waves of sound, in a second, that the human ear can appreciate, varies from eight to over forty thousand. The waves are from .029+ to 139.75 feet in length; the length of a wave, or sonorous vibration, is equal to 1118 feet, the distance sound travels in a second, divided by the number of vibrations in a second.

Very rapid vibrations are very acute in tone, and painful to the ear. It is probable there are sounds in nature too acute for perception by human ears, yet, easily received by the peculiar auditory apparatus of insects and other animals.

The waves of sound are conducted against the membrana tympani, and set it into rapid vibrations, consisting in rapid depression and restoration. These in-and-out movements of the membrane occur regularly, and remind one of the ceaseless agitation of the surface of the ocean. The membrane holds the manubrium of the malleus in position, and supports through it the entire chain of ossicles, which swing pendulum-like in the tympanum, and transmit the vibrations received from the tympanic membrane to the membrane in the foramen ovale of the vestibule, to which the foot-plate of the stapes is attached.

The tympanic membrane keeps the chain of bones in equilibrium, and prevents them from being pushed too far in, or dragged too far out, in order, that vibrations may set them into to-and-fro motion with the greatest ease. The membrane protects the structures of the tympanum from foreign substances and the direct entrance of cold air, and transmits vibrations, also, to the air of the tympanum, to impinge against the membrane of the foramen rotundum in the cochlea.

The ossicles of the ear receive vibrations from the membrana tympani, and transmit them to the oval window. Their articulations and ligaments hold them in position, and permit them to move with great ease through a limited space. They are partially enveloped by a delicate fold of the mucous membrane of the drum, which does not hinder their action.

The tensor tympani muscle is caused to contract by irritation of the inferior maxillary, and the facial nerves, acting through the otic ganglion. It is probable that the muscle acts both involuntarily and voluntarily. It draws the malleus inward and rotates it upon its long axis, so that its posterior border becomes prominent outward, and the posterior segment of the membrane advanced, while the anterior border undergoes corresponding depression with the anterior portion of the membrane.

The muscle steadies the malleus and membrane by its elastic tension, places the membrane in the best condition for vibrating

to high notes, and, acting in unison with the palatal muscles which open the Eustachian tube, it assists probably in changing the air within the tympanum. Lucæ thinks by contracting, it accommodates the membrane for low musical notes.

The stapedius muscle is the antagonist of the tensor tympani; it holds the stapes in position, and prevents its being forced into the oval window. It contracts with the laxator tympani when the facial nerve is irritated, and acts as a check upon the movements of the chain of ossicles, caused by the action of the tensor tympani. Besides the facial filament, it is said to receive another from the motor part of the inferior maxillary nerve. Traction on the stapedius draws the head of the malleus inward, and the lower part of the membrana tympani moves outward. The stapedius draws the head of the stapes backward and outward, so that the anterior end of the foot-plate moves outward a little, the long process of the incus is forced outward and its head inward, dragging the head of the malleus with it. This moves the malleus handle outward, and relaxes the membrane for low tones. Lucæ believes that when it is contracted it accommodates for high unmusical sounds. The normal movement of the foot-plate of the stapes is from $\frac{1}{8}$ to $\frac{1}{4}$ mm.

The fixator basis stapedis serves to antagonize the stapedius, and to prevent it from forcing the foot-plate too far into the oval window.

The laxator tympani is said not to possess muscular fibres, but to act by elastic tension to hold the malleus in position, relax the tympanic membrane, and thus antagonize the tensor tympani.

The membrane of the foramen ovale holds the stapes in position, limits its movements, prevents the escape of the perilymph of the vestibule, and transmits to the perilymph the vibrations received from the stapes.

The membrane of the foramen rotundum, the membrana secundaria, closes the foramen of the tympanic scala and keeps the perilymph within it. It vibrates in unison with the oval membrane, through impulses received from the perilymph, which is continuous from the space around the saccules of the vestibule through the scalæ, but its excursions of from $\frac{1}{1000}$ to $\frac{2}{1000}$ mm. are a little later in time. It vibrates, also, independently from

impulses received from the membrana tympani through the air of the tympanum. These may act directly upon the cochlear fluid and produce sound through Corti's organ. Each vibration inwards may come between two vibrations outwards, produced by the fluid affected by the impulses from the oval membrane, because the vibrations from the vestibule must come later, than those received directly through the tympanic air, though we must remember that fluids and solids conduct vibrations much faster than the air. Thus both sets of vibrations would be intensified, for a spring moving up or down will have its excursion increased by an added force in either direction, as we see when a buggy-spring breaks, when the carriage body bounds upwards after the wheels have gone suddenly into a deep hollow. If these vibrations do not thus alternate and fit together, then those that pass through the air of the tympanum probably act as dampeners to arrest the movements of the oval membrane, caused by the labyrinthine agitations, in order, to permit a new set to have full effect upon the nervous apparatus. I have thought that, perhaps, the oval and round membranes acted in unison during the passage of the regular periodic vibrations of music, and in opposition during the irregular ones of noise.

The mucous membrane of the tympanum covers the tympanic walls and contents, and keeps the cavity moist, and the parts movable.

The chorda tympani nerve has nothing to do with the auditory functions, but merely passes through the ear to its place of distribution. The facial nerve supplies the motor filaments for the muscles of the tympanum, and sensibility resides in the tympanic plexus before described.

The vessels of the ear are devoted to the nutritive processes, as in other parts of the body.

The mastoid cells, with their large, irregular spaces, and the tympanic cavity are filled with air, which is subjected to variations of pressure from the vibrations of the membrana tympani. Low tones cause large movements of the membrana tympani, and considerable pressure in the air of the tympanum; and, as a large tympanum would cause too much resonance, the increase of ca-

capacity necessary for the proper reception of such tones is made in such a way, as to interfere least with the vibrations.

The Eustachian tube conveys air to the tympanum, and mucus out of it. The pharyngeal mouth of the Eustachian tube during regular respiration moves a little, but does not open by itself. When the vowels are pronounced the mouth of the tube opens downward and forms an oblique triangle. Some authors think the upper portion of the Eustachian tube in a normal condition remains slightly open, that air may escape from the tympanum, when the tympanic membrane is suddenly driven in by great pressure. This permits a slow interchange of air between the throat and the tympanum. Professor Moos believes the tube when at rest is closed for two-fifths its length at its narrower part, and this seems a reasonable state for the functional activity of the ear. The whole tube is opened at each act of swallowing, which permits mucus from the tympanum and tube to be worked out by ciliary and muscular action, insures a proper interchange of air between the throat, tympanum, and mastoid cells, and exerts enough counter-pressure upon the inner surface of the tympanic membrane to keep it in equilibrium. The tube opens when great and sudden sounds strike the membrane, and thus prevents shock and injury to the apparatus.

The stylo-pharyngeus, palato-pharyngeus, levator and tensor palati, salpingo-pharyngeus, superior pharyngeal constrictor, and the internal pterygoid, are all concerned in opening the Eustachian tube. In contraction, they raise the mouth of the tube upward, then draw the anterior wall forward, the inferior downward, and the posterior backward, and thus open wide the tube. Eminent authorities are in conflict in regard to the part of the process performed by each muscle. It seems probable they all have some part to play in opening the tube during swallowing, but the tensor and levator palati muscles are the most important.

The tensor and levator palati, acting with the palato-pharyngeus, perform a very important function in dragging the soft palate back against the pharynx, and then shutting off the nasopharyngeal space from below, so that air may be driven into the ears through the nose and Eustachian tube.

Sound waves are best heard when the tube is closed, because

when they strike both sides of the membrana tympani they cause confusion and sometimes pain.

The cochlear walls protect and contain the most elaborate portion of the organ of hearing. The organ of Corti is the æolian harp, which responds to every vibration of the membrana tympani, and furnishes the music of the universe. The ciliated, or hair-cells, of the terminal fibres of the cochlear nerve are moved like the strings of a piano by the blows of sounds, which are transmitted through the membrana basilaris by the fluid of the labyrinth. The cells are grouped and protected by the three thousand arches of Corti, and each one is supposed to be attuned for the reception of a particular tone. The vibrations of music sweep over these hair-cells, as the wind sways the nodding plumes of a wheat field; as the pitch rises, contiguous groups of cells are excited, and there is a harmonious blending of impressions, like the melting of one tone into another, when the loud pedal of the piano is pressed.

The cochlear nerve elements have such delicate sensibility, that expert musicians can distinguish a difference between two notes, whose rates of vibration are 1000 and 1001 in a second, only $\frac{1}{84}$ of a semitone. Every sound is composed of a number of partial tones, and their number and strength make the difference in notes. One of these tones is the fundamental, and the rest are overtones, or harmonics. Every note sets in vibration that part of the organ of Corti belonging to its fundamental tone, and the other parts corresponding to its partial tones.

Noise consists of inharmonious tones, and its irregular vibrations act upon the hair-cells of this wonderful organ, as a child plays with piano-keys. The hair-cells deliver their tremblings of sound to the ultimate nerve filaments, that pass through the habenula perforata and down the modiolus to form the cochlear nerve, and this carries its precious messages to the consciousness.

The membranous semicircular canals and vestibule undoubtedly act as a transmitting apparatus of sound to the brain. The presence of fluid around and inside the saccules and canals, the large distribution of nerve filaments to the ciliated cells, the numerous otoliths adherent and lying free upon these, and the

regular form and position of the canals would seem to indicate great and important auditory functions.

In the higher Invertebrates, the organ of hearing generally consists of a simple capsule, with the auditory nerve distributed to ciliated epithelium upon its inner surface, and containing one or more otoliths; there are no signs of canals or cochlea. In the Vertebrates, one finds a similar capsule (vestibule) containing otoliths, corresponding to the entire ear of the Invertebrates; while the semicircular canals appear, and are developed more and more in the ascending scale. There are at first in fishes two imperfect semicircular canals (*marsipobranchiates*), then in higher fishes three (*elasmobranchiates*), but there are no signs of a cochlea either in fishes or batrachians. If the cochlea is necessary to appreciate musical notes, I would like to know how frogs are able to modulate their merry voices so harmoniously as they do.

The cochlea first appears in reptiles as a slightly curved canal without any scalæ, except in *crocodilia*; in birds, it begins to form a spiral, succeeds in the lowest of the mammals (*ornithorynchus*), and reaches its highest development in man. The semicircular canals are long and narrow in rapacious birds, and large and wide in singing birds,—very significant facts in this connection. All these facts make it certain, that the vestibule and semicircular canals are very necessary for audition, however vivisectionists may deduce the contrary from their mutilating experiments.

The perilymph vibrates from impulses received from the membrane of the oval window, and sets the membranous saccules and canals, with their endolymph and otoliths, into responsive vibrations; these impress the terminal filaments of the vestibular nerve in the saccules and ampullæ, and pass along its trunk to the brain.

The vestibular nerve, also, transmits to the cerebral centres sensations of the equilibrium of the head and body. Experiments upon the lower animals and man indicate, that the endolymph moves in certain directions, according to the movements of the head, and impresses the terminations of the vestibular nerve, so that the individual is conscious of the correct position of his head, and mediately of his body, in space.

Each semicircular canal has a definite direction, and the meas-

ure of the current of lymph depends upon the plane in which the head is turned, and its amount of rotation. Injury of one or more of the semicircular canals causes a loss of muscular co-ordination, and the victim reels and tumbles about in a peculiar manner. Injury of a horizontal canal causes the body to turn around its long axis. Injury of a vertical canal excites a movement of the head in a vertical direction, *i. e.*, around its transverse axis. These motions sometimes occur in man from disease of the internal ear. Authorities differ considerably in their explanations of the phenomena, but, until we have more definite knowledge, the vestibule and semicircular canals must be considered auditory in function, as well as special organs of the new sense of equilibrium.

The auditory nerve is composed of fibres much like those of other nerves, but irritation of them produces only sensations of sound. Hearing is the perception by the sensorium of vibrations as sound. The entire ear has for its object to render the propagation of sonorous vibrations more perfect, and to multiply them by resonance. We judge the direction of the source of sound by comparison, based upon experience of the intensity of the sound in one ear with that of the other. Judgment becomes difficult in impairment of hearing in both ears alike, and of one ear more than the other. The direction may be determined by one ear alone, if it be turned so that sonorous vibrations strike it at different angles consecutively. Estimation becomes difficult, when objects intervene between the hearer and the source of sound, and more difficult, when the objects are large and present many plane surfaces. The distance of the source is inferred from the intensity of the vibrations produced, but the imagination modifies the effect of the sensations in a measure. Vibrations, or their molecular changes, continue awhile in the auditory nerve and its centre after a sound ceases, and persons subjected to a continuous sound for some time, will hear it awhile after the cause has ceased to operate.

Different persons have the auditory apparatus attuned to notes of different pitch. One may be sensitive to feeble tones, and not be able to recognize the musical relation of sounds, while another,

whose hearing for feeble tones is imperfect, may have a lively appreciation of discord and harmony.

Objective sounds come from without, and pass to the auditory nerve through the ear, and, rarely, through the bones of the head.

Subjective sounds arise from within, as a result of irritation of the nerve from other causes than sonorous vibrations.

Ordinary sounds affect the nerve much like a common sensation, and attract little attention; a musical rhythm causes pleasure; an intense tone, pain, and long-continued sounds produce paralysis.

Hearing varies with the temperament of the individual; the condition of the body, whether fatigued or refreshed; the state of the abdominal viscera; and the different states of the atmosphere. It is influenced by reflex action from parts remote from the ear, and impressions made upon the auditory nerve through the usual channel may excite reflex action in other parts of the body.

The auditory apparatus is more complex, even, than the eye, and its functions awaken admiration and astonishment. The ears are the portals of the mind through which much knowledge is gained, and the soul is stirred to deeds of valor and to songs of praise.

ANALOGY OF THE EYE AND EAR.

Structure.—There are certain parts of the ear and eye which, in structure and function, have a sort of correspondence. The properties of sound and light are analogous, and variations in the two great organs of special sense adapt them to the various requirements of the vibrations which act upon them.

The concave surface of the auricle, and the external canal collect and direct the vibrations of sound to the drum-head, as the expanded cornea, aqueous humor, and pupil gather the undulations of light, and transmit them to the lens.

The auricular cartilage, tragus-hairs, and ceruminous and sebaceous glands are comparable to the tarsal cartilage, the cilia, the Meibomian and lachrymal glands.

The similarity in the shape and functions of the drum-head and the lens is obvious; each concentrates and transmits aerial undulations; but the drum-head and its chain of bones must be

taken together, as the analogue of the lens and its capsule, in order not to destroy the correspondence of deeper parts. Then the bony labyrinth and cochlea, with their inner periosteum, represent the sclerotic and choroid coats; the peri- and endo-lymph, the vitreous; the membranous labyrinth and organ of Corti, the retina.

The papillary terminations of the vestibular branch of the auditory nerve may represent the rods of the retina; and the delicate, ciliated cells of the organ of Corti, the cones.

Functions.—Normal ears are generally capable of perceiving the distance and the source of sound, the direction from which it comes, and the position the sound occupies in the musical scale. It is well known that some persons are unable to recognize musical notes. In common parlance, “they do not know one note from another.” So the ability to determine the distance, or the direction of sound, may be absent, though the deficiency is not so readily recognized.

Normal eyes have also a triple function. The retinæ readily perceive the distance, the figure, and the color of objects; but any one of these functions may be deficient. Persons are sometimes found with acute vision for objects, but deficient in color sense, so that they cannot recognize one or more of the primary colors.

The analogy of function between the terminal filaments of the auditory and optic nerves is thus manifest, in the sensibility of the one to the notes of the musical scale, and of the other to the colors of the spectrum; and this throws some light upon the conception of the blind man, who said red was like the sound of a trumpet!

Much may be detected in the correlation of nerves, in accord with the correlation of forces.

CHAPTER III.

EXAMINATION OF THE EAR.

DISEASES of the ear in general are so complicated by abnormal physical conditions, sometimes the cause, but oftener the consequence of the disease, that it is important to detect them, in order to institute those methods of mechanical and instrumental treatment, which long experience has demonstrated to be valuable.

A moment's examination will often lead to a more rational treatment, and a more successful issue in aural disease, than the most painstaking collation of subjective symptoms. The objective symptoms, found by a systematic examination of the ear from all sides, and all the subjective sensations, must be carefully correlated to get the best results from our therapeutic measures; for remedies are as important as medicines in the treatment of aural affections.

A comprehensive knowledge of the pathological condition in aural diseases is acquired by certain methods of manipulation and instrumentation, which should be known by every physician who undertakes to treat diseases of the ear.

These methods are simple and require few instruments, and a certain system of examination should be followed, in order, that everything essential may be elicited, and records of cases may be uniform and valuable for future reference. In addition to the record of the examination, the diagnosis ought to be written out sufficiently full to give a clear understanding of the case, and the prognosis should be made guardedly. Never promise too much, because experience teaches that, in treatment of so complex an organ as the ear, one falls short of the mark oftener than one reaches it. Every physician has cases drift back to him, which he has treated years before, and it is often of great importance to the patient and to science to have an accurate description of just what was the matter, and what was done in the early treatment. From the case-books of educated, systematic

practitioners must the experience of the centuries be gathered, and the advance of medical science signalized.

It is well to have a card in the case-book (unless one gets a case-book printed with headings), with a skeleton like the one below, which can be followed in making the record—a plan which I have found convenient and useful.

Date.	Name.	Age.
	Sponsor.	Address.
1. History and subjective symptoms.		
2. Hearing: Voice [low, medium, or high].		
	Watch: R. E.	Hw. =
	L. E.	Hw. =
Tuning-fork: [meatus, vertex, glabella, mastoid].		
3. Objective symptoms.		
4. Aural region.		
5. Auricle and meatus.		
6. External canal.		
7. Membrane or middle ear.		
8. Throat.		
9. Nose.		
10. Eustachian tube.		
11. Diagnosis.		
12. Prognosis.		
13. Treatment.		
14. Result.		

Many of these divisions may be left out in simple cases, as in recording attacks of eczema of the auricle, but I advise the systematic method to be followed pretty closely, in order to get a complete knowledge of the pathological condition.

It is convenient at the office to seat the patient in a revolving chair, with his back to a table upon which the light and instruments are arranged, or the chair may be placed so that daylight may be used, and the table be located between the patient and the window. A high chair is very convenient for young children. A large oil lamp, or gas with the argand burner, furnishes plenty of light, and I prefer the latter to all other apparatus, as sufficient for thorough examination, for correct appreciation of tissue

changes, and little injurious to the surgeon's eyes. Daylight is very agreeable, and gives the true color of tissues when one uses a magnifying speculum, and, if one is inclined to display and luxury, a Tobold's lamp with its arm mirror and condensing lenses can be both ornamental and useful. Bright sunlight directed into the meatus is now seldom employed in aural practice. In visiting patients at their homes, one can find sources of illumination enough for most purposes.

It is better for the physician to sit during the examination, and the light should be behind and beyond the patient's head, so that it may pass to the mirror, and be reflected at a small angle back into the ear.

The history and subjective symptoms as given by the patient should be recorded, and the physician should by leading questions supply missing links in the chain of testimony. The temperament, condition of general health, and the presence of any dyscrasia should be noted before proceeding to the more particular examination of the ear. Ask about sore throat, coryzas, and chronic catarrhs, the use of tobacco, and if deafness is hereditary.

Objective symptoms should next be gathered. Test the hearing of each ear by the voice, watch, and tuning-fork, and make a careful record as directed farther on. Then look carefully at the auricle, meatus, and region about the ear, and record anything that seems abnormal; push the hair away from around the ear, then run the index and second finger around the attachment of the auricle, pressing firmly in front of the tragus, beneath the lobe, and over the mastoid to find if any soreness is present.

If tumefaction is seen, the pressure should be delicate, and its outlines and relations to the meatus or mastoid process should be determined and recorded.

The mastoid process must be carefully examined for tenderness, redness, swelling, and scars, and sometimes it is well to percuss the part with one index finger for a plexor, and the other laid flat upon the bone as a pleximeter, as thereby deep-seated pain indicative of disease may be awakened.

Some enthusiasts have claimed to be able to determine the condition of the mastoid cells by percussion sounds, but cases

that would give any response to such striking questions are exceedingly rare. It is instructive to take the auricle between the fingers and double the top and the lobe together closely, then move the whole pinna and meatus around by a rotary motion, as this often reveals a soreness not otherwise to be discovered. Soreness and pain may exist in and about the auricle from external affections, without there being any deeper trouble of the ear; but, conversely, deep disease of the ear is frequently accompanied by external soreness and pain.

Take the auricle by the upper part and pull it upward and backward, which straightens the external canal considerably, then examine the meatus and canal by direct light, and then by reflected light from a mirror.

Otoscopes.—There are several kinds of reflecting mirrors, or otoscopes, in use. They are generally concave, from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches in diameter, with a central round perforation $\frac{3}{8}$ to $\frac{1}{2}$ of an inch in diameter, and a focal length of 6 to 12 inches. The hand-mirrors are firmly set in a metal back, and attached to a wooden handle by a rod, screw, or hinge. I have one purchased in Berlin, such as is used by most medical men in Northern Germany, which has a hinge, and possesses some advantages over others. Another larger one, bought in Vienna, has the handle screwed firmly into the back.

FIG. 22.

HAND MIRROR, OR OTOSCOPE.

A piece of looking-glass, with a clear place scratched in the mercury, would serve well in an emergency. The ophthalmoscopic mirror illuminates tolerably, but some kind of a hand otoscope is a necessity for every physician who treats ear disease.

In some cases it is necessary to have both hands free for handling instruments and performing operations, and, yet, one must have a good illumination of the external canal, tympanic membrane, and, perhaps, of the tympanum. For this purpose, a similar mirror to that described above is attached by ball and socket joint, hinge, screw, clamp, or other contrivance, to a plate, fastened upon an elastic band, which fits around the head. Some of these are not perforated in the centre, and are to be placed in the middle of the forehead; others hang low over the brow, so that the central perforation is directly in front of the eye.

FIG. 23.

FOREHEAD MIRROR.

A single mirror is now made to serve for both hand and head otoscope. A handle is screwed into a ball upon its back for hand use, and this is unscrewed and the ball slipped into a socket upon a plate, fastened to an elastic band, for head use. A man busy in aural practice will require both kinds as separate instruments.

The use of an otoscope is simple. The best illumination will be had when the light is accurately focussed upon the part that one wishes to examine, and the observer's eye is placed behind the central hole, through which rays return from the object. There are several other otoscopes of use occasionally.

Blake's otoscope has a large rubber speculum, fitted with a prism and condensing lens, which gives excellent illumination, and permits one to use both eyes in direct vision.

Hassensstine's otoscope is a hard rubber cylinder, with three different sized tubes for the auditory canal. It has an opening

in the side, through which the light enters, and is reflected by a mirror through the tube and lens, so that the eye, placed at the external end, receives an enlarged image of the object.

FIG. 24.



HASENSTINE'S OTOSCOPE.

Brunton's otoscope is upon the same principle. It is made of white metal, silver or nickel plated; has three funnel-shaped tubes of different sizes for the meatus, a magnifying eye-piece, and a large trumpet-mouthed projection upon one side, which concentrates light upon an obliquely placed mirror that reflects it down the tube. It is a handsome and costly instrument, but it

FIG. 25.



BRUNTON'S OTOSCOPE.

gives excellent magnified pictures of the membrana tympani or middle ear, and is very useful in studying minute changes in the membrana tympani and tympanum.

For general use and practical purposes, however, the hand-head mirror and tubular specula will answer, since it is not so difficult to diagnose as to properly treat ear affections.

The light from the mirror should be thrown into the external auditory meatus; and the presence of any extraneous bodies,

matted hairs, and hardened cerumen, and the condition of the skin-lining of the canal should be noted. After examining the outer part of the canal, a conical silver speculum, warmed over the flame in cold weather, should be introduced into the meatus by turning it around and pressing it inward gently by a screw movement with the fingers, while the auricle is pulled upward and backward by the other hand to straighten the canal. If the canal is very narrow, one may have to use a bivalve speculum.

Any obstruction at the inner end should be examined, and, if abnormal, should be removed by syringe, ear-spoon, or forceps, or avoided by turning the speculum aside a little.

The speculum should be held in position in the meatus between the thumb and forefinger, the latter pushed well into the concha

FIG. 26.

ILLUMINATING THE EAR.

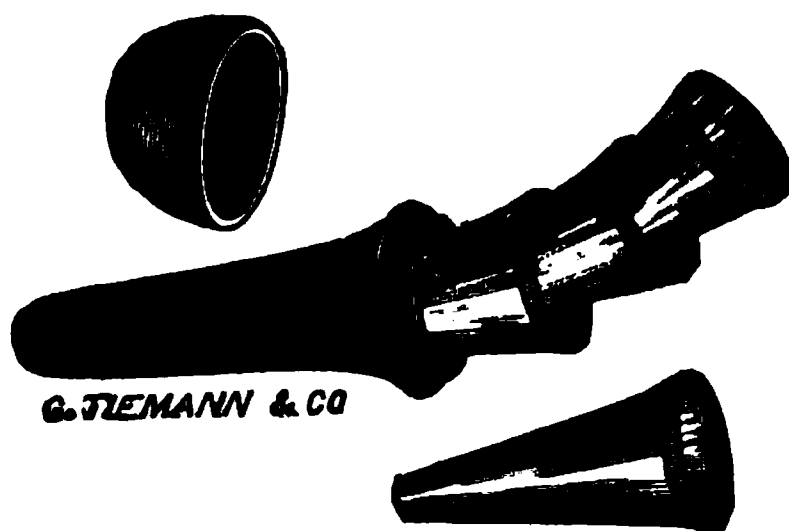
and the auricle pinched between the forefinger and the other fingers placed behind it. It can then be pulled upward and backward to straighten the canal, and moved about to favor different views through the speculum and canal, as the light is reflected deeply into the ear. It is recommended to use the left hand for the right ear, and the right hand for the left ear; the index finger fits thus very well into the concha, and the speculum and auricle can be handled to advantage, but this has the serious disadvantage sometimes of obstructing the light from behind, when the mirror

is held in the other hand, but of course this need not occur when the head mirror is used. I use the right hand for the right ear, and the left for the left ear, when the hand mirror is employed, and thus keep a clear course for the passage of light from the flame behind, and find it just as convenient to handle the speculum and auricle as by the old method.

The auditory canal being illuminated, the state of the skin of the canal, the color, shape, and condition of the membrana tympani, the presence of perforations or polypi, the presence or absence of the ossicles, and the amount of vascularity of the parts, should be ascertained and recorded, with a detailed description of the pathological changes visible.

Ear Specula.—An ear speculum is needed to dilate the auditory canal, crowd hairs out of the lumen, and push the tragus forwards. They are of a variety of shapes, sizes, and materials. Some are made of hard rubber, some of porcelain, and others of coin silver. The rubber and porcelain are not good illuminators, but are economical and useful when it is necessary to make medicinal applications to the deep parts of the ear.

FIG. 27.



WILDE'S TUBULAR EAR SPECULA.

The silver specula are the best illuminators, and are used for diagnostic purposes by all specialists. Specula are from an inch to an inch and a half in length, have an opening at the smaller end from 3 to 6 mm., and at the larger end from 12 to 18 mm. or more in diameter. They have the shape of a hollow cone, or of a funnel, and sometimes are compressed so that the lumen is oval instead of round. The small end is smooth, the large end is

beaded, and both surfaces are bright, though Gruber has fostered a speculum with a blackened interior.

"Wilde's tubular," or straight-sided, conical, silver specula, three in a set, and Knapp's funnel-shaped silver ones in three sizes are the best. Either set will be all that a general practitioner requires.

They take up more room than a bivalve, are apt to wound the canal if pushed in roughly, often push a ring of cerumen ahead

FIG. 28.

KNAPP'S FUNNEL EAR SPECULA.

of them, and are not suited for very crooked canals, or for those compressed from front to back.

There are self-retaining specula, having two valves, a hinge and screw, which are very useful during operations, when one wishes to use both hands. Of these Spier's is the best.

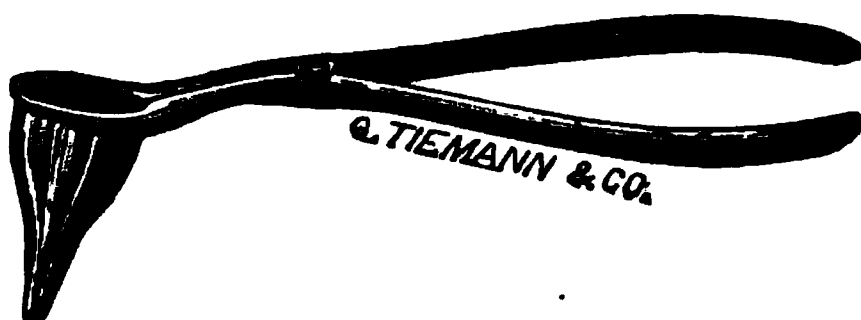
FIG. 29.

SPIER'S SELF-RETAINING SPECULUM.

There are bivalve-dilating specula with handles, such as Kramer's and Tiemann's, used for opening and dilating very crooked

or narrowed canals. The valves of these should be placed upon the anterior and posterior walls, and the handles compressed gently. These are not often required, and belong more to the outfit of a specialist than to that of the family doctor.

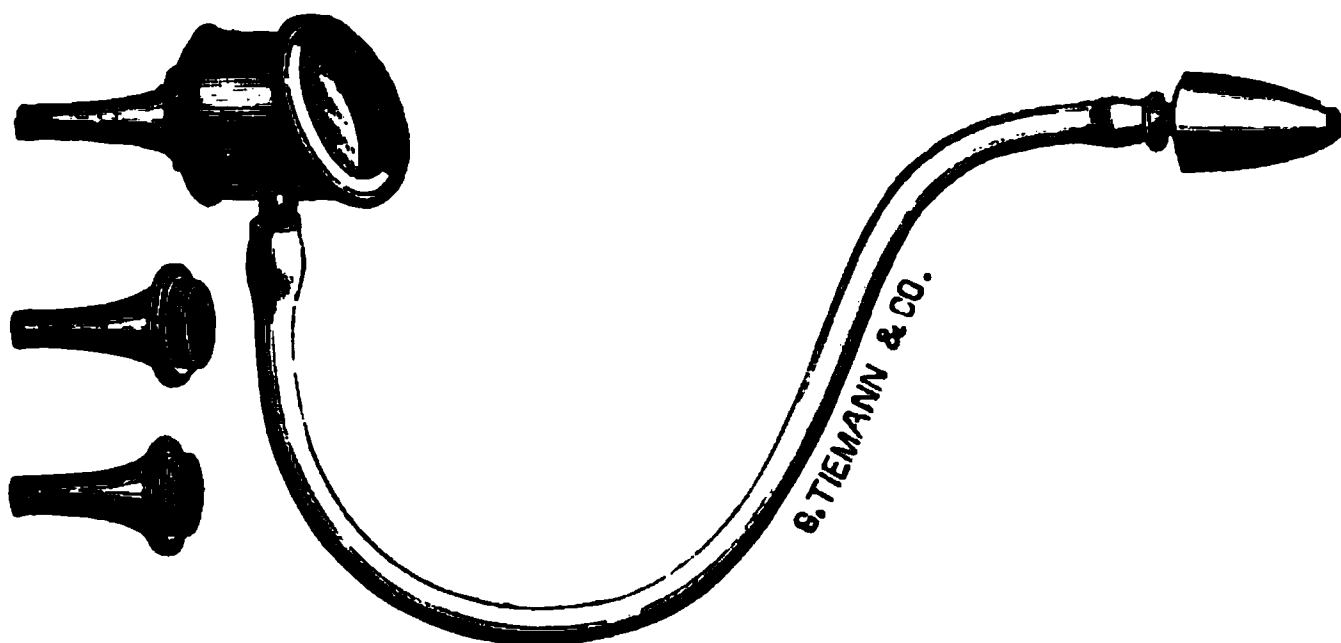
FIG. 30.



KRAMER'S BIVALVE SPECULUM.

Siegle's pneumatic speculum is a short hollow cylinder, having three sizes of graduated tubes for insertion in the auditory meatus, which screw on to one end. The other end is closed hermetically by a clear glass lens. From the side of the cylinder, projects a short tube, to which is attached a piece of rubber tubing, with a mouthpiece or an air-pump.

FIG. 31.



SIEGLE'S PNEUMATIC SPECULUM.

The proper graduated tube to fit the auditory canal under examination is screwed on, and is introduced air-tight into the canal. When this is difficult, a perforated rubber cork fitting the canal may be slipped over the tube. The mouthpiece is placed in the mouth, or the air-pump held in the hands. The membrana tympani is now illuminated by throwing the light from a mirror through the lens closed canal, and the air is rarefied by suction of the

mouth or pump. This causes the membrane, if free, to move outwards, owing to the vacuum produced upon its surface. Sometimes it is well to inflate the tympanum before using the speculum. By alternately exhausting and condensing air in the canal, a to-and-fro movement may be produced in a part or the whole of the membrane. With exhaustion, the malleus handle goes forward, with condensation backward, and its free movement, with that of the membrane above the short process, will indicate free movement of the malleo-incudal articulation, and probably of the chain of ossicles. One can, also, get a tolerably accurate knowledge of the amount of depression of the membrane, and the adhesions present.

FIG. 32.



BLAKE'S MIDDLE EAR MIRROR.

I have used this instrument with the mouthpiece, which I prefer, to produce the to-and-fro movement in the membrane for a minute or two—a kind of aural gymnastics—and am satisfied it has aided in breaking up adhesions and improving the nutrition of the membrane. The instrument should be used cautiously, when perforation of the membrane is suspected, in order to avoid drawing mucus or pus into the mouth.

When the Eustachian tube is impervious, Siegle's speculum is very necessary in making a diagnosis of the pathological changes in the membrane and middle ear.

Blake's middle ear mirror is another instrument recommended

in the examination of diseased spots in the auditory canal and middle ear. It consists of a set of polished steel mirrors from $1\frac{1}{2}$ to 3 mm. in diameter, fastened at an obtuse angle to wires, which when needed are fixed into a handle and secured by a screw.

The light from the head mirror is reflected into the small mirror and the deep parts of the ear examined, as is done by double reflection in other regions. The auditory canal must be large to permit the use of this refinement, but it may be useful in revealing hidden granulations, the exact seat of a polypus, or a carious place behind a projection.

Testing the Hearing—Voice.—The aurist tests the patient's hearing indirectly for the voice during conversation as the first step of the examination, though not designing to do so; but this way is not entirely reliable. It is best to stand a few feet away from the patient upon the side of the ear to be tested, so that he cannot see the lips move, then ask him questions in a low voice. If he cannot hear, address him in a medium tone, and if he is still unable to hear what is said, raise the voice even to a shout if necessary. There are various degrees of hearing for each tone, but low, medium, and high will be sufficiently exact for all practical purposes.

Watch.—The watch test is the most generally used, because we can test a watch and learn how far a normal ear can hear its ticking, and thus get a basis for an accurate record. One may use a special stop-watch, or an ordinary time-keeper. The stop-watch can be stopped and set a going at will, and is valuable in testing children and others, who think they hear when they do not, from a sort of persistence of sensation, after the watch is covered or removed. One can use the ordinary watch for detection by simply turning the back of the hand holding it to the ear tested. It must be remembered that the auditory nerve sometimes ceases to respond—does not hear for a moment—owing to fatigue induced by constant repetition of the same sounds. The sensibility of the nerve is somewhat blunted in old people.

The watch must always be held by the hand, in the same way, in making comparative tests. It makes considerable difference whether one hangs the watch by the finger, or holds it in the

palm of the hand with the whole hand as a resonator. Hold the watch in the palm with its face towards the hearer's ear, say six feet distant, then approach slowly, and learn how far by actual measurement all your friends with normal ears can distinguish the ticking; take the average of these distances and remember it as the normal hearing distance for that watch, to be used as the denominator of a fraction, to express the hearing capacity of patients. In testing a patient, hold the watch six feet away from the ear, having the other ear closed by the finger, approach it gradually until the patient can catch the sound, then measure the distance from the ear by a tape-measure. Suppose a watch can be heard by most persons at sixty inches, and a patient hears it only at twelve; this gives the denominator and numerator of the fraction, and the hearing is $\frac{1}{5}$, or $\frac{1}{5}$ of normal; or suppose the watch is heard only six inches; this gives $\frac{1}{10}$. Make a record R. E. Hw. (right ear, hearing of watch = $\frac{1}{10}$, or L. E. Hw. $\frac{1}{10}$.

In this way one can record the hearing at each visit, and get a mathematical demonstration of the progress made, when the patient makes any.

Some deaf persons can hear the watch a foot away, and, yet, hear only medium tones of voice; others can hear the watch, perhaps, only six inches, yet, understand everything said in a low voice. This difference is due to temperament and close attention. It is not difficult to understand a sentence if we hear three words out of four, and know something about the subject; long words are equal to four or five short ones to a deaf person. Sometimes a person gets, however, "all at sea" lip-reading. I had an amusing instance of a deaf patient's prepossession of the greeting of an acquaintance. Two ladies met. The one not deaf said to the other: "Why, when did you return from the mountains?" The deaf one replied: "Pretty well, I thank you; how do you do?"

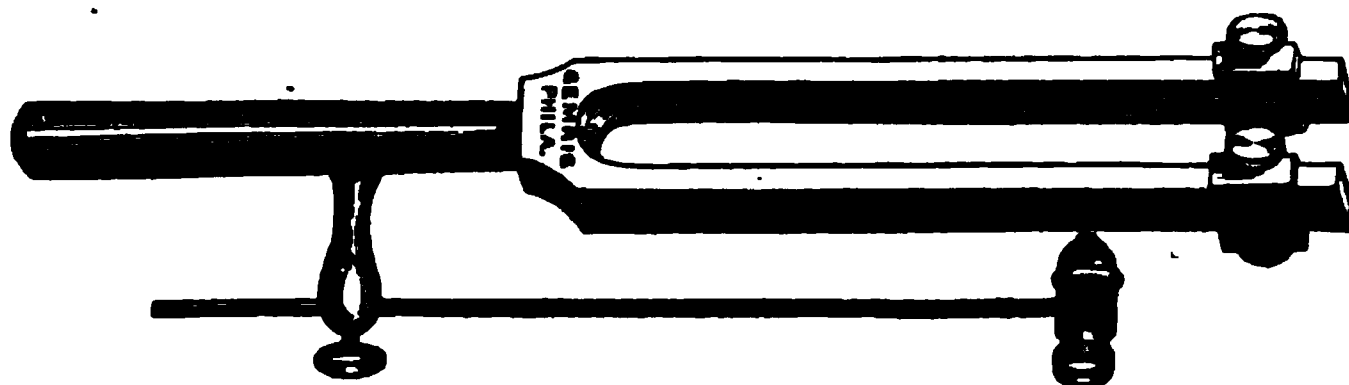
When the watch cannot be heard at any distance, it should be pressed against the auricle, and, if heard then, the record should be made, Hw. = $\frac{c}{60}$ (contact). If not heard at all, write = $\frac{0}{60}$ (nothing). Then the watch may be pressed upon the vertex or the forehead to determine roughly the condition of the middle ear and the auditory nerve.

It intensifies the tick and test to let the watch rest upon a

table; and to press it against the tissues firmly, when it is applied to the skull. If the watch is not heard when applied thus, it is pretty sure evidence that there is disease of the labyrinth or nerve. A watch has only two feeble notes, the nerve fibres for these may be injured, and all the rest healthy, so that the watch is not as good a test as the powerful vibrations of a musical tuning-fork.

Tuning-fork.—Any tuning-fork may be used, but Blake's modification of Politzer's fork, known as the Blake tuning-fork, is an admirable one for several reasons. I prefer the large one marked C. It has a metal clamp upon the upper part of each limb, and a hammer, with one end metal the other rubber, held

FIG. 33.



BLAKE'S TUNING-FORK.

in position by a long spring handle, fastened by a clamp to the fork handle. By moving the clamps the pure dominant tone may be brought out, and any note of the musical scale produced. Similar blows may be struck with the hammer, so that notes and tests are uniform, and one does not have to bang up the furniture as with the ordinary fork. The fork can be reduced to a simple one for general purposes by removing the clamps and hammer from the main part of the instrument.

When the base of a vibrating tuning-fork is placed upon the nasal glabella, the vertex of the skull, or the mastoid process, the internal ear being unaffected, the vibrations are transmitted by the bones of the skull to the fluid of the labyrinth, which impresses the terminal filaments of the auditory nerve, and causes a sensation of sound. During the vibrations, if the external auditory meatus is closed by the finger, the sound is intensified.

Now, when the labyrinth and auditory nerve are healthy, if the meatus or canal is diminished in size, or closed by a foreign

body, or by disease; if the membrana tympani is abnormal, or the Eustachian tube obstructed; if the mucous membrane of the tympanum is thickened so that the chain of ossicles and the oval or round membranes move sluggishly; in fact, if anything hinders the normal transmission of vibrations from the external meatus to the vestibular fluid, the tuning-fork, placed upon the middle line of the top of the head, or upon the forehead, will be heard louder upon that side affected, and better than by the normal ear. If the meatus of the diseased ear in any such case be stopped by the finger, the sound will be considerably increased.

When the sound of a vibrating fork upon the vertex can no longer be perceived, if it be immediately placed at the external meatus and is there heard, it is proof of a normal condition of the canal and tympanum. When the sound of the vibrating fork can no longer be heard at the meatus, if it be immediately placed upon the vertex and is there heard, it is evidence of an abnormal state of the canal or tympanum.

The patient must pay strict attention to his sensations, in order to distinguish slight differences, and must not confound vibrations produced in one nerve through bone conduction, with vibrations in the other, caused by combined bone conduction and transmission through the membrana tympani and ossicles. Even with the fork vibrating upon the vertex, patients are apt to hear considerable through the meatus and middle ear apparatus, and this will vitiate somewhat the result of comparison of sensations from osseous vibrations. Patients will often say, at first, that they hear the fork vibrations better by the ear that they know hears the best *per vias naturales*, whether they do or not. They must be urged to notice the sensations, and make a careful comparison.

Owing to the poor observing powers and stupidity of many patients, the determination of slight disease of the external canal and middle ear by the intensification of bone vibrations is difficult, but for a clean diagnosis of the presence of disease in the internal ear and auditory nerve, the tuning-fork test is invaluable.

A person may be totally deaf in one ear to ordinary sounds, yet, hear the tuning-fork, when vibrating upon the middle line of the skull, better with the damaged ear than with the sound one,

because obstructions to the passage of sound through the tympanum inward, also, act to prevent its diffusion and loss outward.

The fork must be on the middle antero-posterior line of the skull, because if moved to one side the sound may go partly into the meatus of the ear of that side. The vibrations will, also, act stronger upon the opposite more distant ear, because they then move nearer perpendicular to its membrane, than they do to the one upon the near side. Thus the increase of sound in the near ear from proximity, may be counterbalanced in the distant one by approach to perpendicularity in the direction of the vibrations.

If the tuning-fork is heard distinctly when vibrating upon the skull, we may conclude that the labyrinth and auditory nerve are healthy. Just in proportion to the diminution in intensity of the sound from the osseous vibrations, is the departure from health of the internal ear or nerve. When the vibrations are not perceived at all on one side, we may be sure on that side the labyrinth or the auditory nerve is seriously diseased; and, in the absence of cerebral symptoms, and the absence or presence of middle ear disease, it is tolerably certain that the disease is in the labyrinth, affecting, of course, the terminal filaments of the nerve. Cerebral disturbance, and absence of aural symptoms, except deafness, indicate disease of the nerve, the medulla, or contiguous structures.

Roosa says, "Cases of diseases of the middle ear that are connected with disease of the labyrinth, or cases in which the middle ear is sound on one side while the nerve is affected, and just the opposite state of things exists on the other side,—that is, the middle ear is diseased and the nerve sound,—will of course render the value of the tuning-fork less positive, and a differential diagnosis difficult."*

If one labyrinth or nerve only should be affected, of course, the vibrations would be heard in the other ear. If both labyrinths or nerves should be affected, they would be heard best in the ear least diseased, provided there were no middle ear or external canal

* A Practical Treatise on the Diseases of the Ear, including the Anatomy of the Organ. By D. B. St. John Roosa, M.A., M.D., etc. William Wood & Co., New York City, N. Y., 1873.

disease. Should both labyrinths or nerves be diseased, and the conducting apparatus of one side be affected, that side might respond best to the vibrations, even, when its labyrinthine structures were the most affected, for we know that obstruction outwards intensifies vibrations through the cranial bones.

It is evident that one must have his wits about him, and be very careful in his use of the tuning-fork, if an examination is to cast light upon obscure cases.

The Acumeter is an instrument constructed somewhat after the principle of the Blake fork, and designed to be used in its place for testing the reaction of the auditory nerve, both through the canal and by means of the cranial bones.

It consists of a steel cylinder, 4 mm. in diameter and 28 mm. long, fastened at right angles to a vulcanite columnar body,

FIG. 34.



THE ACUMETER.

which is held between the index finger and thumb. There is a slot in this body, a little removed from the foot of the cylinder, in which moves a wire handle of a steel hammer, that strikes the cylinder near its end. The movement of the hammer is arrested at a certain point by a shoulder, so that the blows and the sounds it makes are uniform. Another wire rod, having a disk upon one end, is fitted to the body at a right angle to the hammer. The disk is placed against the head to test the bone conduction; but without the disk the instrument serves as a producer of sound to test the tympanic apparatus.

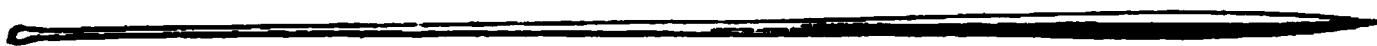
Cleansing the Ear.—The external canal frequently contains dirt, unhealthy cerumen, epidermic scales, projecting hairs, in-

spissated pus, etc. Sometimes the canal may be tolerably clean, and a perforated or partially destroyed membrane be covered by pus, which fills the tympanum and hides the parts. It is fre-

FIG. 35.



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COTTON HOLDERS.

quently necessary to remove much offensive matter before a speculum can be used in the canal with any satisfaction, and there-

FIG. 36.

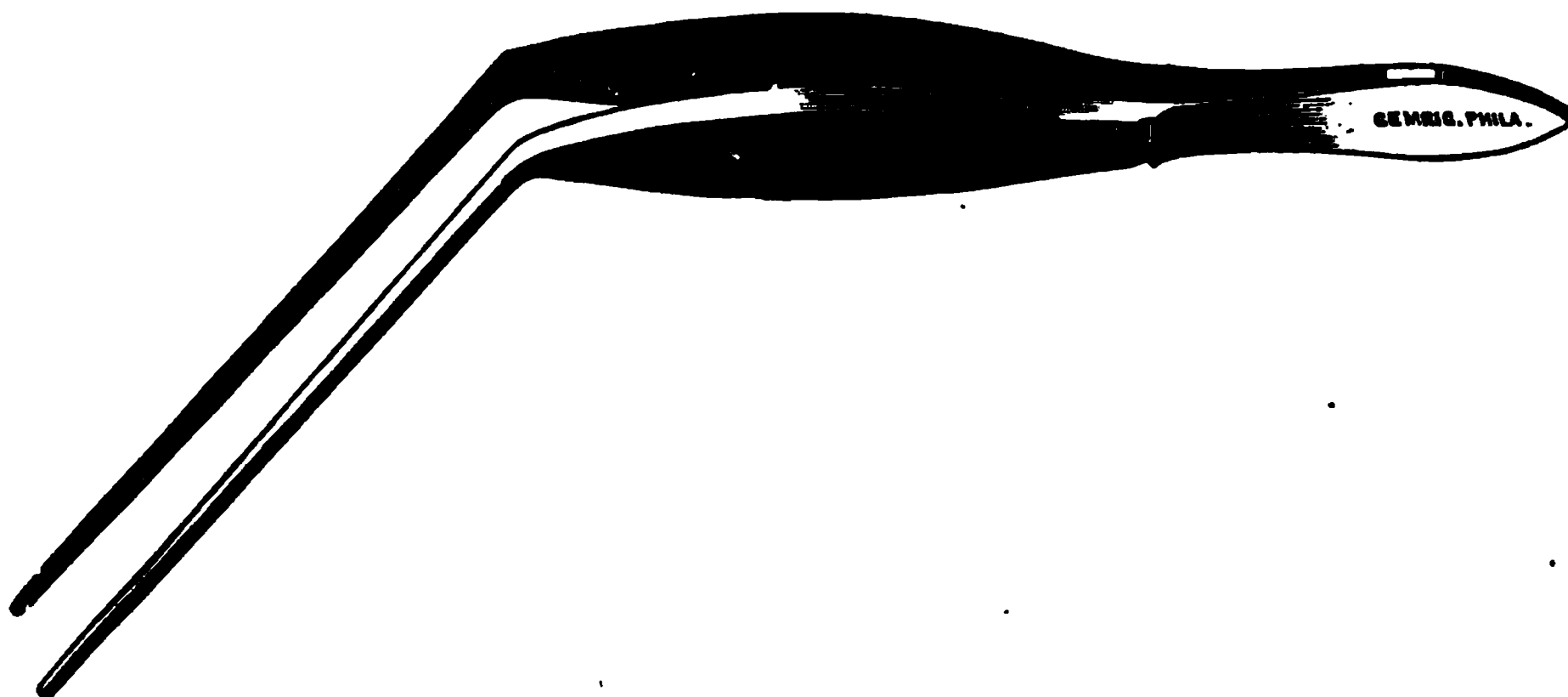


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EAR-SPOON AND HOOK.

fore cleansing measures are necessary. Particles and pieces clinging to the canal walls, and not too far within the meatus, may be removed under good illumination by twisting cotton around the

FIG. 37.



ANGULAR EAR FORCEPS.

roughened end of the cotton-holder, wetting it with glycerine and water, and turning it around in the canal.

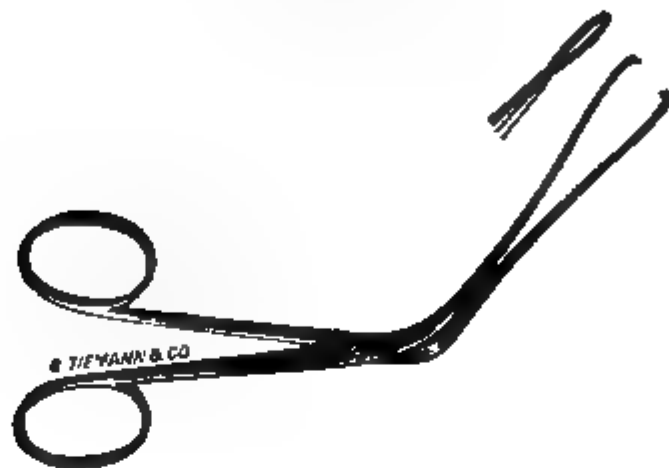
The ear-spoon and hook, the angular forceps, and Pomeroy's

forceps, will prove very useful in the hands of a delicate manipulator.

They must be used very gently within the meatus, and care be taken not to injure the epidermic and other tissues.

When the canal is much occluded, particularly, if the tube con-

FIG. 38.



POMEROY'S EAR FORCEPS.

tains hardened cerumen or pus in any quantity, a good syringing with warm water will be necessary. Any common syringe will do the work in the hands of an intelligent person, but there are several syringes of especial merit for the use of specialists and those who can afford them.

Syringes.—The improved fountain syringe, No. 1, I have used with much satisfaction. It has no valves to get out of order,

FIG. 39.

IMPROVED FOUNTAIN SYRINGE.

is self-acting, the flow is unbroken and steady, and it injects no air. Shut down a clamp upon the tube, then fill the bag and

hang it up, the higher the more force is required; slip in the proper nozzle, lift the clamp, and direct the stream at will.

The difference between its action and that of the ordinary piston instrument, is similar to that between a placid brook in a meadow and the stream of an old town pump. It is especially suitable for children, who are so easily made frantic by any irregular and energetic movements about the ear.

The cheap bulb syringe and the more expensive Davidson's are next to the fountain for mere cleaning purposes. At my clinic

FIG. 40.



HARD RUBBER EAR SYRINGE.

at the Children's Hospital (Twenty-second and Locust streets, Philadelphia), I used a bulb syringe, connected with another bulb by tubing, so that pressure upon the lower one kept up a steady flow from the nozzle; the combination sending a continuous stream of water, as the double bulb atomizers do of spray. The glass syringes are an abomination and a snare to the uninitiated. A

FIG. 41.

KRAMER'S EAR SYRINGE.

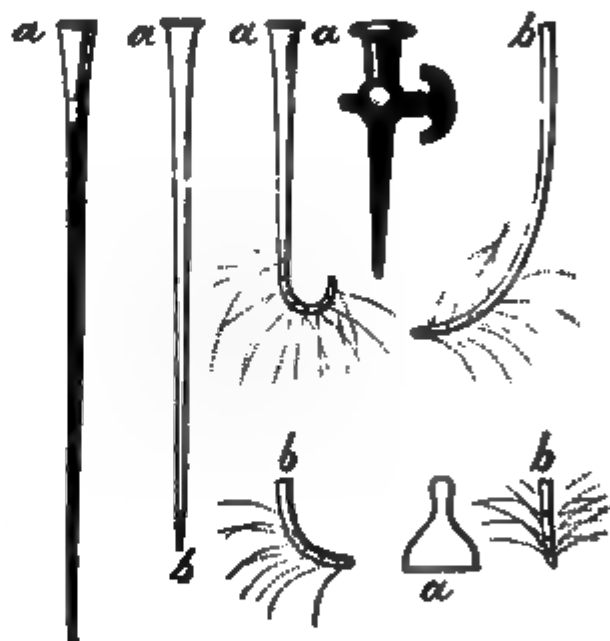
hard rubber syringe, of one-half or one ounce capacity, is necessary for every well-regulated family, and is very useful in cleansing the ear. It is essential to have a small nozzle, so that a fine and forcible stream of water may be thrown close to the canal wall for the removal of hardened cerumen and foreign bodies. The

one I prefer has a shoulder for the first two fingers, and a ring for the thumb, and can be easily managed by one hand.

Kramer's syringe has two side rings for the first two fingers, a piston ring for the thumb, and a graduated nozzle for the catheter. It is easily handled, and a favorite with many aurists.

One of the best hard rubber syringes for the ear is the Universal, an ounce syringe, with a ring on the piston for the thumb, and a projecting shoulder at the base for two fingers. It has a variety of rubber and German silver tubes, two of which fit the catheter; quite a forcible stream can be thrown with it, and it is the most useful instrument for syringing out foreign bodies,

FIG. 42.



UNIVERSAL SYRINGE.

impacted cerumen, and scales of epidermis. The vulcanite syringes should have one blunt-shaped nozzle for general use.

Syringing.—It makes a great deal of difference how one uses a syringe. Loose dirt, pus, scales, and pellets of cerumen are removed from the auditory canal by simply directing the stream from any common syringe into the meatus. When the contents are obstinate, and one has picked out with the spoon and forceps all that is *easily* removable, the syringing must be vigorous and the stream directed with care. For this purpose, the hard rubber syringe with a small nozzle is the best. The water had better be warm, and be kept in a special vessel; the first syringing should

be very gentle, and the process not too long continued at one sitting. It is well to have a small gas-stove handy to heat water rapidly when needed, though not too cold water may be used without much risk of exciting inflammation. Put a clean towel around the neck and shoulder upon the side to be syringed, tucking it in to protect the patient's clothes.

FIG. 43.

EAR-BOWL.

Give the patient a finger-bowl, a common china bowl, or tin cup, to hold against the side of the neck, under the ear, to catch the escaping fluid; an assistant is needed to do this if the patient is a young child. There are special ear-pans recommended, but except the one figured above they are abominations.

An ear-spout may sometimes be used to advantage.

FIG. 44.



EAR-SPOUT.

Introduce the nozzle about half an inch into the meatus, direct the stream of water into the canal, and continue injecting until the canal seems clear.

It is best to examine with speculum and mirror every minute or two, so that should opposing material be removed, one may stop the syringing and prevent injury to the membrane. To insure thorough work, draw the auricle upward and backward to straighten the canal, and direct a strong stream close against the upper canal wall. This will be necessary, particularly, for very

hard cerumen and foreign bodies. One may assist their exit occasionally with spoon and forceps; their careful use is frequently necessary and permissible, notwithstanding the strong counter-teaching of some authors, who condemn this manipulation, because instruments in the hands of rough and injudicious men have done injury to the auditory canal.

Patients frequently become vertiginous from the syringing, particularly after the membrane or middle ear receives the stream unbroken by any intervening substance, and, rarely, a patient may vomit or faint away, so that one must be prepared for squalls, and have a basin and a reclining chair handy. I have had a few patients who were obliged to recline during the operation.

FIG. 45.

SYRINGING THE EAR.

No person can syringe his own ears well, and when cases must of necessity be treated at home, the operator must be carefully instructed in the details of the procedure. Only the initiated succeed well.

After syringing, the ear should be wiped with the end of the towel, and a finger covered with it pressed well into the meatus, the head being a little bent towards the affected ear, in order to absorb the surplus water. If the examination through the speculum shows any remaining water, or there be shreds and particles of pus remaining in the canal or tympanum, they should be carefully wiped out with pieces of cotton twisted around the cotton-holder. The absorbent cotton of the shops is an excellent article,

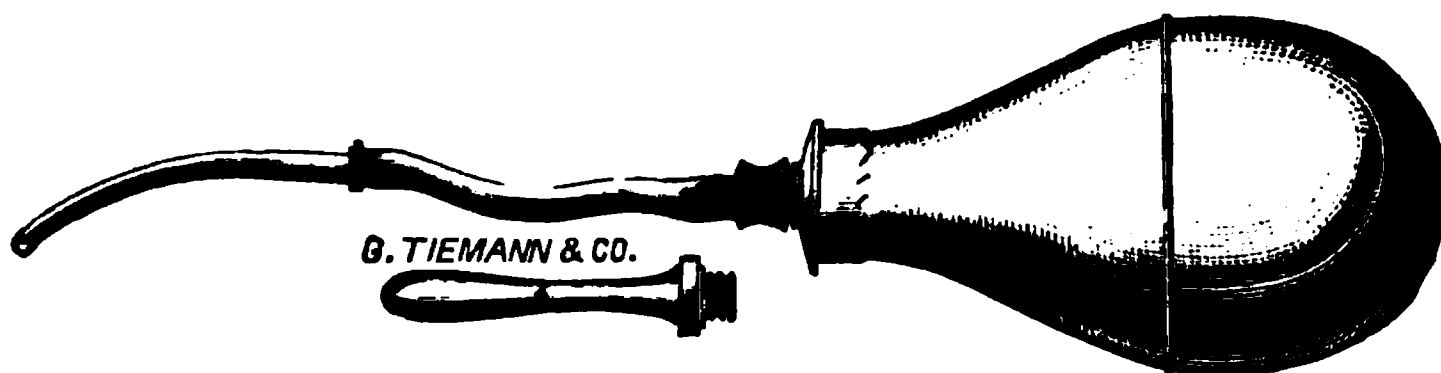


it greatly facilitates thorough cleansing, and is now largely used in aural practice. After thorough cleansing of the canal, illuminate it well with the mirror and speculum, and examine it carefully.

When the membrana tympani is intact, note its color, transparency, translucency, vascularity, mobility, adhesions, and other conditions. The appearance, position, and mobility of the manubrium of the malleus ought to be carefully observed. The Siegle speculum should be applied to determine the mobility of the membrane, and position and extent of adhesions. Other means and instruments are necessary to find out the condition of the middle ear and Eustachian tube.

Inflation and Auscultation.—Aural patients owe a debt of gratitude to Dr. Politzer, who introduced a simple, painless method of opening the Eustachian tube and filling the middle ear with air.

FIG. 46.



POLITZER'S AIR-BAG.

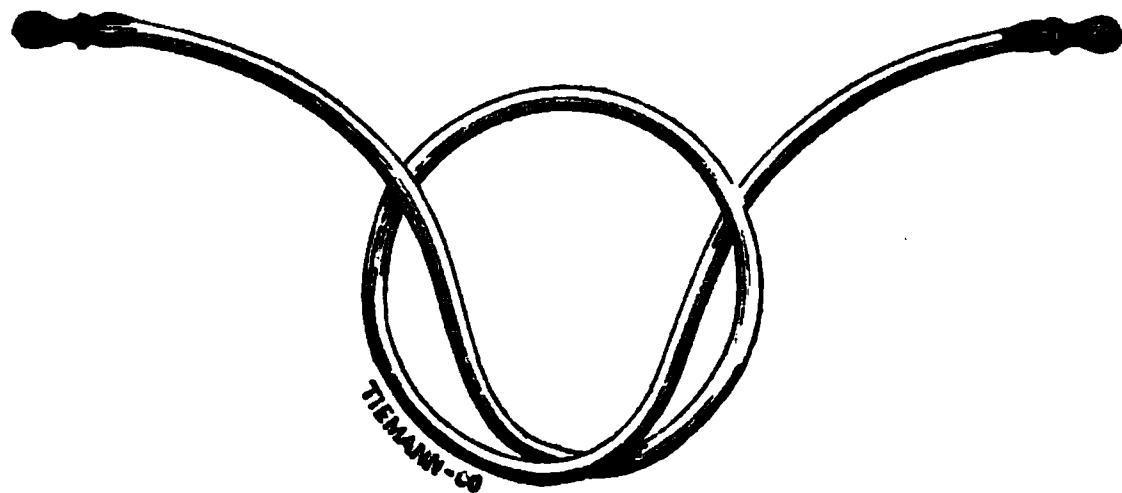
The Politzer Air-bag consists of a firm, compressible rubber bag, either oval or pear-shaped, with a small hole in the base, and a slender nozzle on the opposite end, which is attached by a short piece of rubber tubing to a tubular nose-piece of hard rubber, 8 cm. long and 5 mm. in diameter, and slightly curved at the distal end.

This nozzle may be put in the inferior meatus of the nose, but patients do not like it, and I substitute for it an olive-shaped hard rubber nozzle, or a beak-shaped glass nose-piece, which just fits the anterior nares. Inflation is just as successful with them as with the original nose-piece, and there is no pain caused, as neither goes far enough into the meatus to press against the turbinated bone. Sometimes during inflation a little air goes through the lachrymal passage and makes a queer sensation, but I have

never known any harm to be done by it. One patient said he felt as if his nose was growing, which led to the discovery that his left lachrymal sac was considerably distended at each inflation.

An auscultation tube, for use with the air-bag, or any other method of inflation, consists of a piece of soft rubber tubing from eighteen to thirty-six inches long, with a small bone, or hard rubber perforated tip at each end. One end is placed in the patient's and the other in the surgeon's ear. The tips are usually straight, but the one for the surgeon's ear should be bent a little, so that it may be better retained in position. Dr. Burnett recommends a tube a yard long, so that one end may be inserted in

FIG. 47.



AUSCULTATION TUBE.

one ear of the doctor, and the tube go around back of his neck to the opposite side, and then direct to the patient's ear. A tube applied in this way is more liable to remain in position, than when entirely upon one side.

Cover the patient's chest by a towel tucked under the chin, fix the auscultation tube in proper position in the ears, give him a mouthful of water, and tell him to hold it and swallow at the word. Now push the nose-piece of the air-bag into one of the patient's nostrils, in the direction of the inferior meatus and a little away from the septum, hold it firmly in position and close the other nostril with the thumb, or press the alæ of the nose firmly with the thumb and index finger. Grasp the bag firmly, with the thumb placed over the hole in its base, say, "Swallow!" and the next moment compress the air-bag vigorously and notice the sounds which come from the auscultation tube; then take the

thumb from the hole and remove the nose-piece. When inflation succeeds, there is often a clucking sound mixed with various râles, heard by both patient and physician, and the former experiences a fulness in the ears.

I explain that I wish to blow a little air through the nose, and it will not hurt, but only feel peculiar. It is well to blow gently the first time, especially with children, in order to insure confidence. Both ears will usually be inflated by this method. To diminish action upon one ear, stop its meatus firmly with the finger. This seems to have some effect by reflex action in hindering opening of the Eustachian tube. Turning the head towards the shoulder of the side you wish to protect will sometimes do it.

FIG. 48.

INFLATING THE EAR.

A certain way of limiting the action to one ear is to inflate through the Eustachian catheter, and this will be desirable when the other ear is in a normal condition.

When a person swallows, the palatine and pharyngeal muscles, not only open the mouth of the tube, but they draw the soft palate back against the posterior part of the pharynx, and shut off the naso-pharyngeal space above from the throat. In a normal condition, air enters the ear with each act of swallowing. The air from the bag is condensed in the nasal fossæ and the superior portion of the pharynx, and, stretching the walls, forces apart the lips of the Eustachian tubes and rushes through them

to fill the tympanum. A blast of air in one nostril is likely to affect one ear more than the other. Often this is on the same side as the nostril used, occasionally on the opposite side. I have found dry deglutition, or the swallowing of a little saliva, sometimes to insure inflation when swallowing water did not, probably owing to a closer contraction of the throat muscles. Instead of swallowing, one may use what I call the educational method. In this the patient keeps the mouth wide open and the head back, and as the bag is compressed he ejaculates in a guttural manner the words, *hic, haec, hoc, hunc, hanc, hoc* (hick, hank, hunk were the words recommended by the physician who first suggested this method).

Each method may be tried until success crowns the effort. Occasionally a patient will not be able to keep the soft palate back against the pharynx, but it will yield, burst open, and air will distend the cheeks and escape from the mouth, or go down the throat. Then there is usually a failure to inflate. To obviate this, I make the patient bend the head far backwards during the use of the bag. If this fails, I have him turn his head sharply over one shoulder, and give him a blast in both nostrils as he swallows; then let him turn his head over the other shoulder, and give him another double blast. These positions change the relations of the trumpet ends of the tubes with reference to the posterior nares. By these manœuvres I have often succeeded when simpler measures failed, and thus avoided the use of the catheter, which is so much dreaded by most patients.

The Valsalvian method is another way of inflating the middle ears, which many ear patients will be found to know all about. The patient takes a deep inspiration, closes the mouth, puffs out the cheeks, holds his nostrils closed, and forces air upwards from the lungs to fill the mouth, throat, and nose. This is a convenient method for the doctor, who should observe the motion and appearance of the membrana tympani during the experiment. The air does not go so directly and forcibly, and the manœuvre is not so beneficial in removing mucus, dilating the tubes, and airing the middle ear, as when the air-bag fills by a sudden blast the nasopharyngeal chamber and tympana. The congestion of head and ears, owing to the suspension of respiration, sometimes really injures

the ear. It may be used moderately, however, under the physician's directions, but the patient should be warned that he may increase his deafness, if he persists in the measure by himself.

The operation by the air-bag should be repeated several times until it is certain the ears have been inflated. One must judge of this by the patient's sensations, by the auscultation tube, and by the increased vascularity and improved position of the membrane. He may say he heard a cracking, and that his ears feel stuffed up; this sensation disappears usually after swallowing.

When the membrane is perforated, there is usually a bubbling, hissing, or whistling sound, as the air escapes through the opening and out of the external meatus.

Deafness to the voice, subjective noises, stuffiness or pain may cease immediately after a successful inflation.

The surgeon should inspect the membrane, which, if the operation has succeeded, will show less depression, a more prominent umbo, and a reddening of the vessels along the manubrium of the malleus.

The auscultation tube when used during inflation will often determine the question about the opening of the tube, and give one an idea of the size and condition of the tympanum. When the patient swallows, the air-bag is compressed quietly, or the Valsalvian method is employed, the operator listens for any sounds that may come to his ear from the ear of the patient. He will sometimes distinguish a soft hiss, moist crepitation or bubbling, or a soft dry cracking, both near and distant. When the parts are healthy there is a sound like *whoo* in a whisper. If no sound is heard the Eustachian tube is obstructed in some way. The soft hiss indicates mucous adhesion of the Eustachian tube and may be followed by *whoo*, if the tympanum is nearly normal, or by moist crepitation if there is exudation in the tympanum. If sounds are clear and come quickly, the exudation is thin; if duller and slower, it is thick and probably in the tube. When there is a dryness of the tympanum, ankylosis of the ossicles, and some movement of the membrana tympani, cracking is produced by inflation.

In the open tubes and dry tympana of old persons the sounds

are rough and rasping. Patients of acute sensibility frequently hear these sounds during inflation, after they get a little used to the shock. The auscultation tube is rather more reliable when the inflation is made through the catheter.

Vertigo is not uncommon after inflation. Shocks may occur when adhesions in the tympanum give way, as air is forced violently into it for the first time. A patient once fainted in my office from such a cause. She heard a tearing sound and felt sharp pain in the ear.

In treating infants, the ear may be inflated easily. A simple rubber tube with a mouth-piece in one end and a perforated tip in the other, much like the diagnostic tube, should be used instead of the air-bag apparatus. Have the child held, take the mouth-piece in the mouth and put the tip in the patient's nostril, compress both nostrils with tip retained and blow steadily. The child will cry, inhale, choke a little, draw the soft palate back, then swallow and the peculiar gurgle will indicate that the deed is done. One may verify the operation by examining the membrane when possible. Older children will readily submit to the air-bag after a little coaxing and gentleness on the part of the physician.

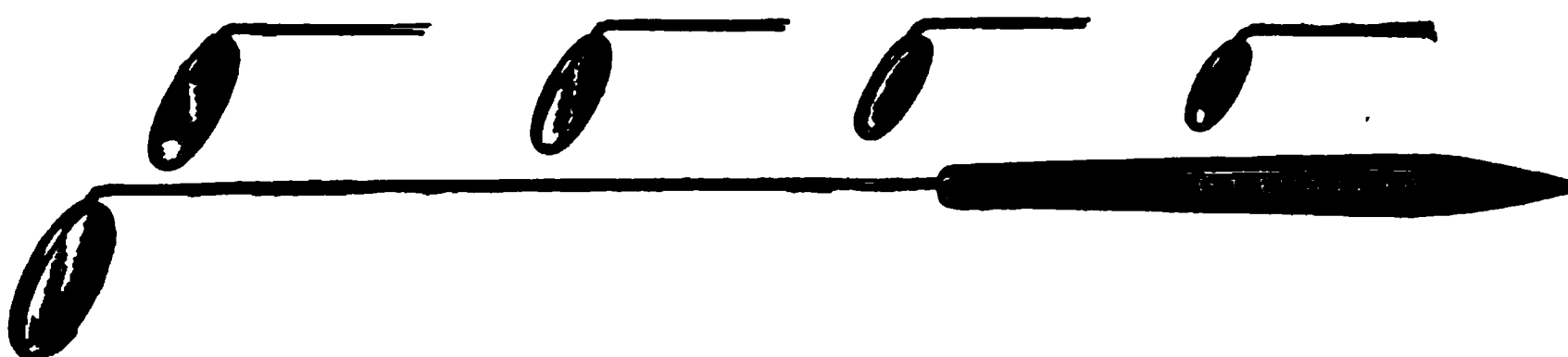
The air-bag alone should not be used in acute rhinitis, acute angina, ulceration of the nasal fossæ or in cleft palate.

It is a blessing to the aurist, at least, that young children are not brought in crowds to be treated for ear diseases, because unless they are anæsthetized, it requires about three persons to put each one through an ordinary examination. It is a curse to them, however, not to be treated, as older patients in clinics and deaf and dumb asylums show.

Examination of the Throat.—The Eustachian tube, nose, pharynx and throat should be inspected in every case of aural disease. Have the light stream over the shoulder of the patient from behind, put on the head mirror, reflect the light into the throat, hold the tongue down with a tongue depressor in the left hand, and look at every part of the post-oral region. The size and condition of the tonsils, the position and action of the palato-pharyngeal and palato-tubal muscles, and the appearance of the

mucous membrane and glands of the throat and pharynx should be noticed. Tell the patient to say *aye*, and a little higher view of the pharynx may be obtained, but to see the upper portion of the pharynx, the mouths of the tubes, and the posterior parts of the nasal fossæ, a rhinoscopic mirror must be used. A set of round or oval silvered glass mirrors backed by metal and from $\frac{1}{4}$ to $1\frac{1}{2}$ inches in diameter is desirable. Each mirror is attached

FIG. 49.

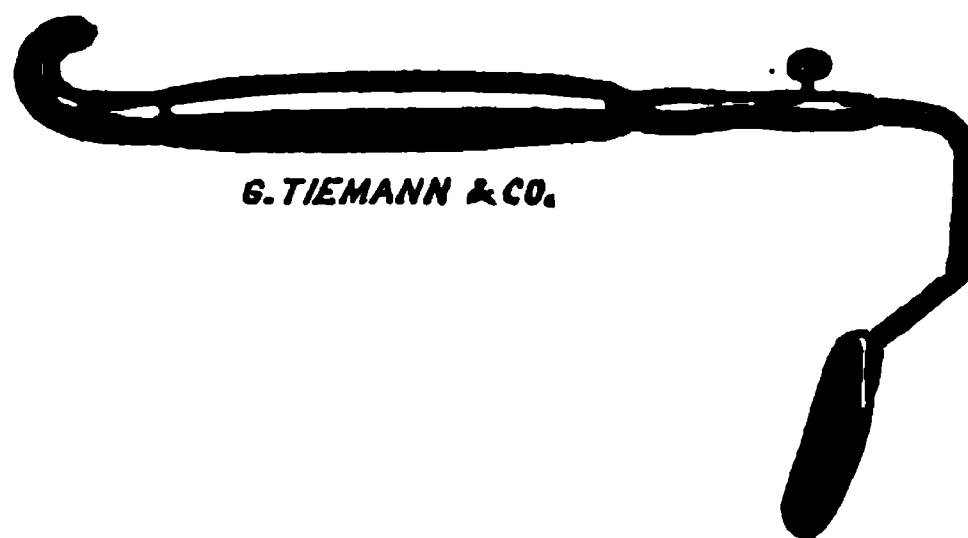


RHINOSCOPIC MIRRORS.

at an angle of about 120° to a strong wire stem, and when one is needed it is slipped into a universal handle and fastened by a set-screw.

Examination of the Naso-Pharynx.—Seat the patient back to the light, with the head bent backwards, and reflect it into his

FIG. 50.



TÜCKER'S TONGUE DEPRESSOR.

throat by hand or head mirror. Select the mirror to suit the case, by estimating the space between the velum and the pharynx, and fix it in the handle by the screw. Take it in the right hand, as the pen is held, warm it slightly by holding the glass surface over the burner, so that the vapor of the patient's breath will

not cloud it, and introduce it into the throat with the angle horizontal. Have the patient hold the tongue by the tip, or with a

FIG. 51.



TONGUE DEPRESSORS.

tongue depressor, or the surgeon may hold it with the depressor, or the handle of the mirror. When the mirror reaches the phar-

FIG. 52.

EXAMINATION OF THE PHARYNX.

ynx, hold it close to the pharyngeal wall, but not touching, reflect the light into it from the large mirror, turn it upwards

and around in different positions, and observe the pictures therein. The mirror should be held steadily and not titillate the parts or gagging will result. If the uvula is too long, a slip noose should be passed around it, then draw it forwards and fasten the thread between the incisor teeth; in some cases it may be cut off. If the tonsils obstruct the round mirror, use a small oval one. If the palate goes back too much, have the patient breathe only through

FIG. 53.

EXAMINATION WITH TOBOLD'S APPARATUS.

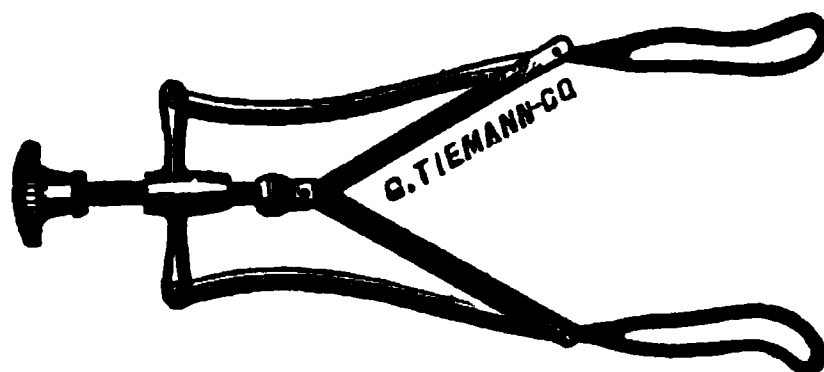
the nose. This is difficult, but is facilitated by keeping the jaws very wide open. Some throats are so small as to make such an examination impossible, but generally a tolerably good view may be obtained of the posterior nares and palate, the roof and sides of the pharynx, the mouths of the Eustachian tubes, and the larynx.

The mucous membrane should be carefully examined for mucous masses, thickenings, rugose swellings, enlarged glands, adhesions, false membrane, ulcerations and morbid growths. The patulency and condition of the mouths of the tubes should receive

careful attention, in order to judge whether the disorder of hearing is due to tubular disease, arising primarily in the pharynx, or to disease of the tympanum.

Examination of the Nose.—The nasal fossæ may be in such

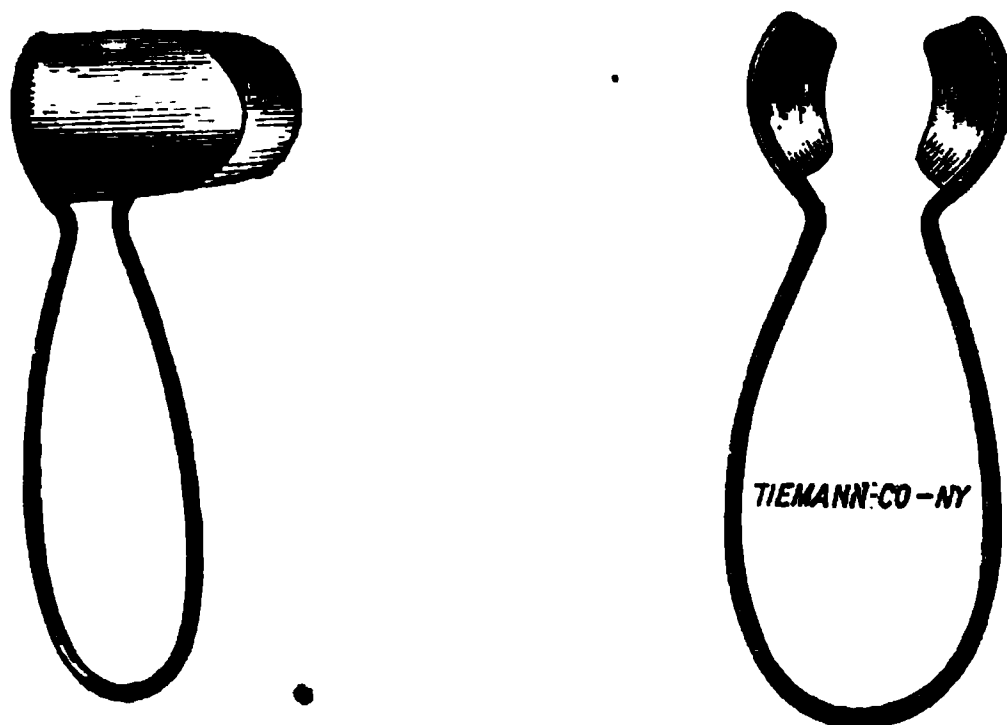
FIG. 54.



FRANKEL'S NASAL SPECULUM.

a condition as to demand treatment, and should be thoroughly explored. The rhinoscopic mirror will generally reveal the state of the tissues in the posterior nares and nasal fossæ, and a specu-

FIG. 55.



THUDICHUM'S NASAL SPECULUM.

lum should be introduced into the anterior nares to facilitate further examination. The head or hand mirror may be used to illuminate.

There are several specula necessary. Frankel's is a useful and convenient one. It is of nickel or silver-plated steel, works

with a screw, and leaves plenty of room between its branches for surgical work.

Thudichum's consists of two bivalves connected by a wire, and is a favorite with many specialists. Elsberg's is more of a dilating instrument, it has three branches and is convenient. Zaufal's long tubular specula may be useful in determining the state of the naso-pharyngeal space, and become a necessity in examining cases in which it is impossible to get a view of the parts with the throat mirror, on account of narrowness of the space between the palate and the posterior surface of the pharynx.

Careful exploration by the index finger passed through the mouth to the roof of the pharynx and, even, into the choanæ, should confirm the presence of morbid growths in this region,

FIG. 56.



ZAUFAL'S TUBULAR SPECULUM.

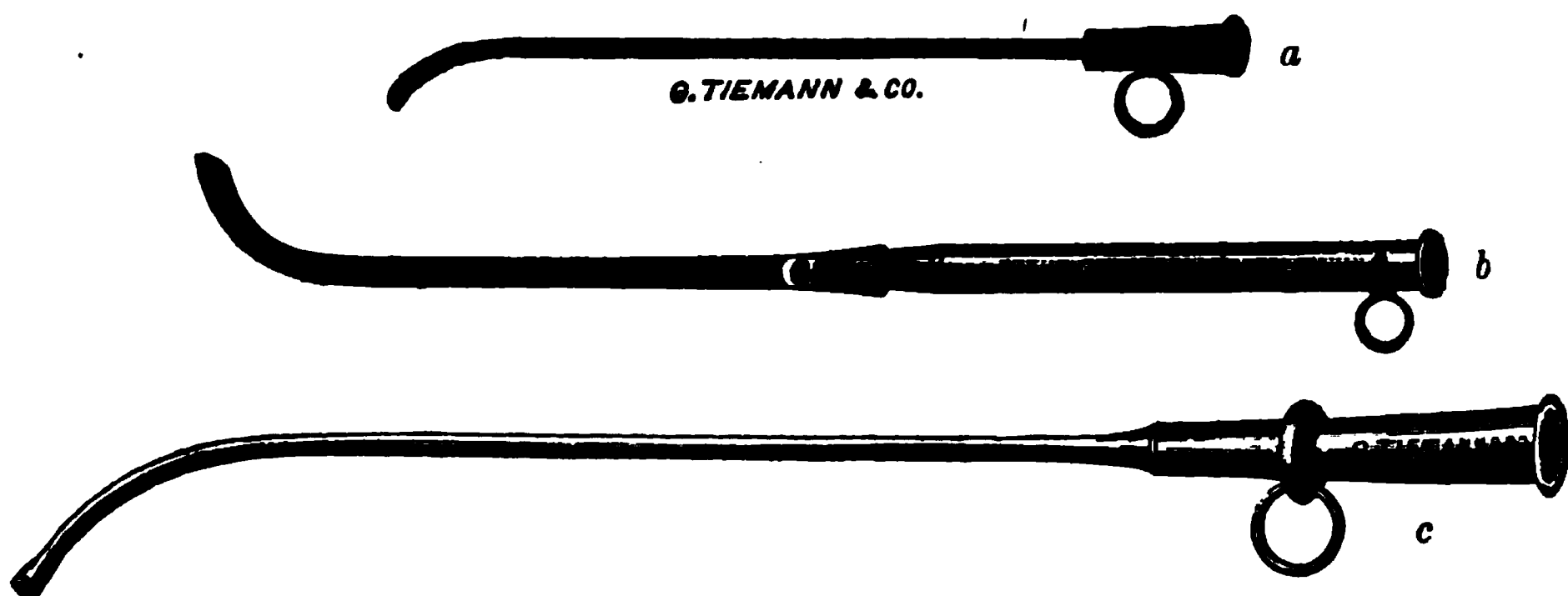
before operation, as recommended by Loewenberg. The state of the mucous membrane, size of the passages, deformities of the septum and turbinated bones, and the presence of ulcerations, swellings and tumors, should be noticed and recorded.

The teeth should be examined in all cases of pain in the ear, when other symptoms of aural disease are absent or insignificant, as odontalgia occasionally causes violent earache and even inflammation of the middle ear through the otic ganglion and the auricular branches of the fifth nerve. There is no doubt in my mind that numerous cases of subacute and chronic disease of the tympanum are caused by diseased teeth and the various metallic fillings put in them, as stated by Dr. Sexton. I have seen plenty of cases in which the evidence of this connection was irrefutable.

Examination with the Eustachian Catheter.—This is another means of diagnosis of naso-pharyngeal, tubal, and tympanic disorders.

Eustachian catheters are tapering tubes about six inches long, with a slight curve at the small end and a ring upon the large end, in the same plane as the curve, to show the position of the latter when out of sight in the nose. Some catheters have the ring upon the same side as the curved beak, others upon the opposite side. The small end should be a little rounded like a silver probe, not left sharp as some are, and the diameter of the large end should be sufficient to take a syringe nozzle, and a tapering tip from the air-bag. They are made generally of hard

FIG. 57.



EUSTACHIAN CATHETERS.—*a*, Hard rubber catheter; *b*, Sexton's velvet-eyed catheter; *c*, Silver catheter.

rubber, and of coin silver, which materials are well adapted to the purpose they have so long served. Every aurist knows the frequency with which slight bleeding is caused by the most careful introduction of these instruments, and I have had occasion many times to file off the sharp edges of the beak in new sets, in order to save the feelings of hypersensitive patients, and to avoid abrasions of the tender naso-pharyngeal mucous membrane. It occurred to me that a catheter of soft rubber, sufficiently firm to answer most purposes, might be manufactured, and owing to its soft beak and easy flexibility, be inserted without any of the discomfort and damage incident to the unyielding ones.

I communicated with Messrs. G. Tiemann & Co., the eminent

and ingenious surgical instrument makers of New York city, who set immediately to work and produced the instrument desired.

This corresponds in shape and dimensions with the medium size catheter furnished in sets, is stiff enough to be handled easily, and to retain the nozzle of the syringe, or the tip of Politzer's air-bag, yet, is so soft and yielding as to glide over obstacles, and do no damage to a tender, granular mucous membrane. It works well, can be made stiffer in its straight part by slipping in a wire if thought necessary, and its merits will commend it to every one engaged in aural practice.

The manufacturers will keep it in stock and designate it "The Flexible Eustachian Catheter."

Dr. Sexton, of New York, has invented a catheter, which is made of soft rubber and silver. It is indicated by *b*, Fig. 57. The base consists of a silver tube, with a ring similar to the outer half of the ordinary silver catheter. The other half, receiving the distal end of the silver tube and ending in a tapering curved beak, is made of soft rubber, and resembles mine in its delicate touch and uses. The base is so heavy that the instrument is troublesome to keep in position, and it slips out of the nose and separates from the rubber part too easily.

The hard rubber catheter should be used generally, when steam or medicines are applied to the Eustachian tube and ear, as the silver ones become heated or corroded. Catheters come in sets of three in each material, the sizes are small, medium, and large; but one should have a number of sets, so as to have clean ones always ready, and to be able to fit odd cases. They should be washed after use in boiling water containing a little carbolic acid, in order to prevent carrying disease from one patient to another.

Occasionally quite a small catheter may be needed for a child, but the hard rubber ones may be heated and bent to any curve to fit special cases. It is better to avoid the use of the catheter in children, and to rely upon other measures.

Persons with a wide brain case often require a much greater curve in the catheter, than those with a narrow one; not always,

however, because with the wide brain, one may have great muscular development and a close throat; and with the narrow, atrophic muscles and a capacious cavern of a pharynx.

Anglo-Saxons have broad cerebral bases and require, generally, stronger curved catheters than the Latins who have narrower ones. I usually estimate the curve of the catheter necessary, by noticing the width of the head on a line with and behind the eyes, and succeed in selecting the proper instrument in most cases the first time.

Short thick noses take catheters of large size; long slim noses require small ones; the inferior meatus varies much in size. A child's catheter is slender and little curved. The catheter which can enter the Eustachian tube easily, of course, shows approximately the size of its lumen.

Select the proper catheter, blow through it to be sure it is pervious, warm it in a bowl of hot water or over the gas-jet, especially, if it is of metal and it is winter weather, and take it between the thumb and first two fingers, as most persons hold a pen. Have the patient clean his nose well and hold his head steady and erect. Now take hold of his nose with the left hand, raise the tip a little and introduce the beak of the instrument into the nostril half an inch or more, with the curve directed downward and a little inward. Direct the patient to breathe entirely through the nose in order to keep the velum immediately away from the posterior pharyngeal wall. Raise the catheter to nearly a horizontal position with the beak resting upon the floor of the nose near the septum, and push gently backwards until the back of the pharynx is reached. One can tell this by the length of the catheter inserted, the obstruction to further progress, the coughing or gagging, and the grimaces of the patient. The instrument should be held loosely and moved in gently, so that no injury may be done, and the instrument may follow a crooked passage if such be present. I usually put the index finger upon the outer end, after starting the instrument in, and push gently and firmly onward, allowing free lateral play, and when the back of the pharynx is reached turn the ring so that the curve within shall be downward.

After reaching the pharyngeal wall, hold the catheter horizontal against the septum, withdraw it about half an inch and turn its ring about a quarter of a circle (90°), to insure the turning of the inner curved portion outwards to the same extent, then push a little backwards and the beak will enter the mouth of the Eustachian tube or else the fossa of Rosenmüller. In the latter case, the catheter can be rotated largely and will not retain its position long. One should then draw it a little forward, keep the ring down a little and the beak turned outward, push the outer end against the septum and the instrument backwards, and the beak will slip into the mouth of the Eustachian tube.

Sometimes a sensation as if breaking threads is felt and a little bleeding is caused, from the giving way of granulations as the beak is pushed home. The palate muscles may lift the beak into place very easily, but contact of the catheter with the velum often causes considerable pain and some bleeding. In difficult cases, ask the patient to swallow and this action will frequently assist in lifting the catheter into the tube. After it is in position, swallowing will in most cases move it slightly. It may be necessary to turn the catheter and repeat the manipulation several times before it will get into the proper place. It may be advantageous in some cases to turn it in an opposite direction, make three-quarters of a revolution, and drop the beak into the mouth of the tube from above. When this is done, some writers direct to hug the septum with the curved beak, but the space for operation is so small that this direction is superfluous. Occasionally the catheter will be turned during insertion by the walls of the inferior meatus and go directly into the mouth of the tube.

The palato-pharyngeal muscles frequently contract upon the catheter and hinder its insertion. One should wait till the patient breathes calmly through the nose and the spasm yields. A little patience only is necessary, the velum will become pendulous and the course clear.

No decided force should be used in introducing a catheter, as serious injury may be done to the mucous membrane. If after insertion the catheter can be rotated but a little, and a cartilaginous grip is felt at the inner end, one may be sure it is in proper position. Introduction of the catheter may cause tickling, or itching

in the auditory canal, a stopped feeling in the ear, sneezing, cough, epistaxis, swallowing, gagging, nausea, vomiting, burning pain in the throat, neuralgia of branches of the fifth nerve, and injury of the tube. The catheter can be used before it is fixed in position, as an explorer for thickening of the mucous membrane, and the detection of morbid growths. Knowledge gained in this way, however, is not very reliable.

One can tell the catheter is in position by the elastic cartilaginous feel, an inability to rotate it far, by the position of its ring, by the ability to inflate the tympanum through it, and by ocular inspection with the rhinoscopic mirror. I must mention that the position of the ring when the catheter is *in situ* is variable. The rule is horizontal or a little downward, but it points as frequently upward and outward; in such cases, one will notice that the auricle and external auditory meatus are a little below the plane of the nasal floor. There are some fancy methods of introducing the ordinary catheter that I will not allude to.

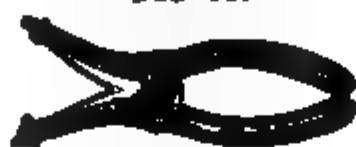
There are cases of total obstruction of one side of the nose to the introduction of the catheter, which are caused by irregular and deformed turbinated bones, lateral displacement of the septum, swollen mucous membrane, adhesions between its surfaces, and the presence of adenoid, polypoid and osseous tumors in the inferior meatus and pharynx. These obstructions should be removed when possible; and operations upon the nasal septum and turbinated bones are justifiable and proper.

The Eustachian tube of one side may be reached, however, through the other side of the nose. Dr. Noyes has invented a pair of double-curved catheters for this purpose. The curves are in planes at right angles to each other, and the beak is considerably prolonged.

Auscultation.—It is premised that the catheter is now in position; it may be retained by Bonnafont's nose clamp; the patient may keep it in place by pinching the nose and breathing through the mouth; or the surgeon may hold it between his thumb and forefinger, the other fingers resting upon the forehead. One tip of the auscultation tube should now be pushed firmly into the corresponding auditory meatus of the patient and the other into the surgeon's ear. The surgeon may then place his

mouth to the catheter, blow quickly, and listen to the sounds that come to his attentive ear. Instead of this method of inflating, a tapering tip in the air-bag may be fitted into the catheter, and air forced through by quick compression of the air-bag. Another

FIG. 58.



S. TIEMANN & CO.

BONNAFONT'S CATHETER HOLDER.

way is to use Toynbee's explorer, a rubber tube, fitted with a tip for the catheter and a mouth-piece for the surgeon, the breath is blown through it and the catheter. This method makes much less noise and permits the sounds through the auscultation tube

FIG. 59.

AUSCULTATORY CATHETERIZATION.—1, The patient; 2, the catheter;
3, the physician; 4, the auscultation tube.

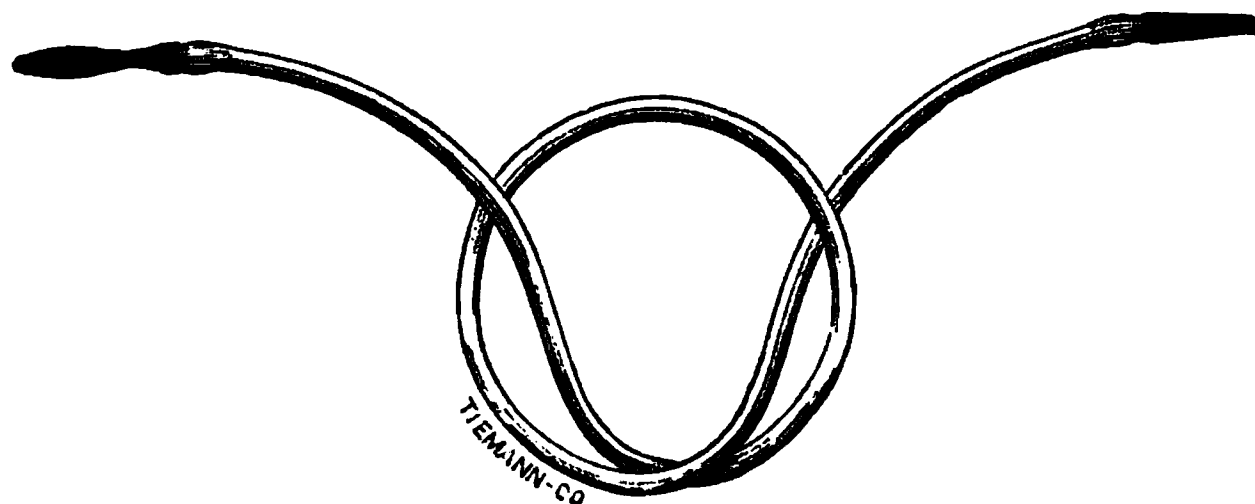
to be more readily appreciated, than when the air-bag is used. If the Eustachian tube is pervious, air will be forced into the tympanum, and certain sounds will come through the auscultation

tion tube to the surgeon's ear, which he may interpret according to hints previously given.

If air cannot be heard rushing or bubbling through the Eustachian tube and the tympanum, and the patient does not feel any fulness or improvement in his ear after several trials, the tube is impervious. Redness along the handle of the malleus is occasioned by examination of the auditory canal, and by the use of instruments in the throat and about the mouth of the tube, and must not be considered sufficient evidence of air having reached the tympanum.

When inflation is made as a therapeutic measure, two or three blasts are sufficient to change the air of the tympanum, but half a dozen may be made without injury, when much stimulation is

FIG. 60.



TOYNBEE'S EXPLORER.

needed for diseased conditions, and it is desirable to expel mucus, and, especially, when one wishes to stretch and dilate a contracted tube.

Bougies.—When obstructions are found in the Eustachian tube, they are usually at the isthmus or junction of the cartilaginous with the bony portion. Several kinds of bougies are used for their removal. They are made of catgut or soft metal, are longer than the catheter, and should be marked at just the length of the catheter, and then have another mark outside of this to indicate the average length of the Eustachian tube. One may know then just how near the tympanum the instrument is approaching, as it is pushed through the catheter. The bougie is introduced through the catheter in position and used like a sound to dilate actively, but little force should be employed. The laminaria bougies are

designed to dilate strictures and the tubes passively, by the swelling which they undergo when moistened. They are made of *laminaria digitata*, are considerably longer than the Eustachian catheter, and should be marked like those of catgut.

The catheter being in position, a bougie of this kind is introduced through it beyond the stricture and allowed to remain some time. After it swells somewhat, the catheter may be removed and the bougie left as long as considered desirable. Sometimes they have been broken off, and pieces have finally escaped from the tube with benefit to its calibre, but this seems a hazardous and undesirable sequel.

Entotic Test of Hearing.—Dr. Bing proposed a comical test of the ear. He connected by means of rubber tubing, an Eustachian catheter *in situ* with a bell-shaped collector of sound, and then spoke through it directly into the tympanum. The external meatus should be closed tightly, the patient should not be permitted to watch the aurist's lips, and should repeat what he hears. The results from this method are of little value, and I present it here merely to show the versatility of the Teutonic mind.

Symptoms.—Diseases of the auditory apparatus have a variety of common symptoms. The most frequent and noticeable is deafness, and the patient is not conscious of this until it has reached a certain degree, when he perhaps notices it by accident. A person with normal auditory apparatus can hear an ordinary watch four or five feet, yet, his hearing may decline until he can only hear it a foot or less, and he may still hear the voice well enough.

One's friends notice the demand the moderately deaf person makes for a repetition of sentences for his understanding before he does himself, and brusque ones may tell him that he is getting deaf, while polite ones will say nothing, but set him down as stupid. There are many children and adults credited with dullness who are simply deaf, and it is cruel to reprimand and abuse them, when an examination will reveal their affliction, and save them much misunderstanding and mortification.

Deaf persons learn to watch the lips of the speaker, and thus gather in sense, when they cannot altogether compass the sounds, and their defect becomes manifest when circumstances prevent

their lip-reading. The wistful look in the face, the anxiety to hear what is said by friends, and the morose dulness and discontent manifested by many deaf persons are distressing to behold.

Causes.—It is self-evident that, though congenital deafness may result from defective development or deformity, acquired deafness is caused by disease and degeneration of the auditory apparatus. Late autumn, winter, and early spring are pregnant with changes of temperature and humidity, and are fruitful in acute inflammations of the ear, and acute exacerbations of old affections. In this six months of the year in the temperate zone, catarrhal and erythematous diseases hold high carnival, and numerous are the cases of aural mischief in every community. In all damp and changeable climates ear diseases are much more prevalent, than in warm equable ones.

Temperament exercises a marked influence upon the genesis of aural disease. The lymphatic temperament is seen in three-fourths of the cases of disease of the middle ear, and in many of the external ones. It is the temperament of catarrhs, and both the sallow-faced and the blooming blonde are victims of fluxes from the mucous membranes from almost inappreciable changes.

The sanguineous are afflicted next in frequency, but adults are more subject than youths; the ear disease is frequently phlegmonous and violent in its nature, and causes great suffering and some danger.

The nervous are attacked in moderate numbers; the disease is mild and manageable, the patients exaggerate their sufferings and make loud complaints.

The bilious suffer least from serious disease of the ear; they are prone to subacute and painless disorders, which advance slowly and seem of little importance, until they begin to diminish the auditory power.

Heredity is another cause of deafness, and aural disease can often be traced through several generations.

Deafness affects the young more than the old, though each period has some diseases peculiar to it; it is found in males oftener than in females, owing to their greater exposure; it attacks those of impoverished blood and afflicted by some dyscrasia; it occurs in those devoted to a life of great cerebral activity and, hence,

hyperæmia, and those exposed to the shocks of sea-diving, the foul air of mines and sewers, the whizzing and clanging of machinery and tools, and the roaring of artillery.

Among exciting causes are: chilling some part of the head or neck, as by a draft or exposure to cold air; chilling the body as a whole, especially, after having been in a warm room, and, perhaps, perspiring; suddenly cooling the ear; irritating the membrana tympani, and shocking the apparatus by swimming and diving in salt water; the abuse of tobacco in chewing and smoking; attacks of tonsillitis, pharyngitis, diphtheritis, nasal catarrh, mumps, measles, and scarlatina; the introduction of foreign bodies, and vegetable and animal parasites into the external meatus; and traumatic injuries, from the digging with a hairpin, to fracture of the temporal bone. These are the most common exciters of aural disease; but, in many instances, struma, the rheumatic and gouty diatheses, or the syphilitic contamination of the system have prepared the ears for an explosive inflammation.

Diagnosis.—The diagnosis of aural disease must be based upon an accurate knowledge of the normal appearances and physiological action of the auditory apparatus, and this, so easy of acquirement, is just what many physicians neglect. Every opportunity should be taken to examine the membrana tympani, its color and movements during inflation and phonation, the appearance of the ossicles if visible, and the hue of the middle ear. The naso-pharyngeal space, the mouth of the Eustachian tube, and the movements of the palato-pharyngeal muscles should be studied closely by methods and instruments already described.

When a patient complains of some functional disturbance of the ear, a knowledge of the natural conditions will enable one to determine with accuracy the cause, consequence, lesion, and treatment. Without this analysis of a case, treatment must be irrational, unscientific, and hazardous.

The pathology of the ear has been so well worked up that a special volume is required to contain it. Very much of inestimable value has been garnered from uninviting fields by the patient labors of devoted physicians, but I do not hesitate to say, that, in several directions, the advances are useless and soul-

vexing—mere curiosities of science, and monuments of mis-spent energy.

Histology has been a fashionable pursuit during the past decade, as was once the South Sea craze and the Tulip mania, and therapeutics has been left to the druggist's apprentice, and the fossilized grandmothers of medicine. With a few exceptions, the talent of both schools has been led captive by the charms of microscopic histology and medical physics, and the full value of medicines in the treatment of aural diseases remains in an undeveloped state, a reproach to the science of medicine, and to our common humanity.

Treatment.—The treatment of ear disease consists in certain measures, which experience has proved to be beneficial; in a careful use of such medicines as correspond in their characteristic symptoms to those of the disease, and in such others as experience has proved of value in the morbid conditions.

The paucity and unreliability of ear symptoms in our pathogeneses of medicines make it imperatively necessary to resort occasionally to remedies, which have only a clinical record to authorize and indicate their uses.

A medicine having a pathogenesis corresponding very nearly with the totality of constitutional symptoms *may be* the very best remedy for an ear affection, but frequently the symptoms in the aural region constitute nearly the entire totality, and a resort to the materia medica will show little to correspond. In such cases, I hold it fraudulent to ignore the important symptoms of the ear, and to abstract and use a pretentious and deceiving totality from the recorded fancies and follies of imaginative provers. Ear diseases cannot be cured in this manner, and much better is it to rely upon clinical experience for the treatment of these cases, than to waste time in following Will o'the Wisps into the bogs. Adherence to the principles of treatment presented in this book will enable the physician to treat aural diseases with a fair measure of success, as the experience of many eminent aurists has been epitomized for a foundation for my own practical contributions.

CHAPTER IV.

DISEASES OF THE EXTERNAL EAR.

Malformations.—Congenital, imperfectly formed auricles are exceedingly rare, and usually accompany deformities of the temporal bone.

The auricle may be entirely absent or represented by a small nodule, several nodules, a flap, a crumpled distorted mass, an hypertrophied and enlarged appendage, or by several rudimentary auricles. The meatus is sometimes filled by soft tissue, cartilage

FIG. 61.

MICROTIA AND STENOSIS OF THE MEATUS (Schwartz).*

or bone, leaving a minute canal or none at all. Over these the skin passes smoothly or shows a slight depression. Among many thousand cases of ear disease, I have seen but one unfortunate, a girl of six years, with the right ear malformed. There was a slight wall of cartilage representing the antihelix, concha, and spine of the helix, with a nodule projecting outwards from

* The Pathological Anatomy of the Ear. By Hermann Schwartz, M.D., Professor in the University of Halle; Translated by J. Orne Green, A.M., M.D., Aural Surgeon, Boston City Hospital, etc. Houghton, Osgood & Co., Cambridge, Mass., 1878. This classical treatise upon aural pathology, to which I am under obligations for several beautiful plates and valuable notes, ought to be in the library of every physician.

the latter. The lower and posterior portion merged gradually into the neck, and the position of the meatus was covered by a thick tight skin, which yielded very little to pressure. The appendage occupied the normal position, the rest of the body was well formed, and the child intelligent.

Defective development of the auricle usually corresponds with malformations of the external canal and other parts of the ear,

FIG. 62.

MALFORMED AURICLE AND ATRESIA OF MEATUS (Schwartze).

and operative measures are advisable only in very exceptional instances.

Dr. F. H. Schell, of Cincinnati, Ohio, reports a case of hypertrophy of the auricle in a boy, the other auricle being of normal

FIG. 63.

CATS-EAR OF LEFT AND HYPERTROPHY OF RIGHT AURICLE (Schwartze).

size. This is so rare, that I append the substance of the Doctor's report.

"Charlie L., aged five years, presented the singular deformity of different sized auricles. The left one was much the larger and thicker of the two; was very red and vascular, and became more so and puffy in cold weather and after manipulation; it lopped over, which made it only the more conspicuous. The boys called the poor little fellow 'lop ear,' and 'muley.'

"A day or two after the child's birth, his parents noticed a difference in the size of the ears, and discovered, also, a couple of

FIG. 64.



HYPERTROPHY OF THE AURICLE (Schell).

tumors in the scalp above the larger one. The larger one grew rapidly, till at five years, it was $3\frac{3}{8}$ inches long, $2\frac{1}{2}$ inches wide, and proportionately thick.

"The anxious parents had consulted many physicians and surgeons, who had resorted to all kinds of treatment, cutting, blistering, injections, setons, etc., which did no good, but destroyed the attollens muscle (accounting partly for the lopping), set

up violent inflammation and erysipelas, to which the child had twice nearly succumbed, and left the ear covered with unsightly scars.

"The little tumors in the scalp had been extirpated, but otherwise, as might have been expected, there was no improvement in the hypertrophied organ. At this stage of the case I was consulted, and I decided upon an operation to reduce the size of the auricle, though with some misgivings on account of the intolerance of manipulation previously manifested. At the first operation, the patient having been chloroformed, I excised a portion of

FIG. 65.

THE HYPERTROPHIED AURICLE AFTER THE OPERATION (Schell).

the auricle, brought down the rim, and secured the edges firmly and evenly with half a dozen wire sutures on each side. The hemorrhage was quite copious, but easily checked by twisting the cut ends of the arteries.

"I used Calendula water for sponging, and gave Aconite for several days after the operation. The wound healed promptly without suppuration, or leaving any conspicuous cicatrix behind.

"The ear after recovery still looked thick and stumpy, and stood out too much from the head, to relieve which, I performed a second operation. I made an incision in the cuticle of the pos-

terior surface of the auricle nearly its whole length, and as near the line of junction with the scalp as possible. I then joined the two ends of this incision with another incision, enclosing an elliptical piece of integument, which was excised. I dissected up the whole of the integument of the back of the ear as far as the external border, and removed a thick layer of dense cellular tissue, then brought the cut surfaces of the integument together, secured them with sutures, applied a cotton dressing and bandages, and prescribed Aconite. The wound healed again very kindly by first intention, and the final result of the operation was excellent. The ear was still somewhat thicker than the other one, not quite so translucent, but otherwise so nearly like it as not to attract any special attention."

Another malformation rarely seen is the existence of a sinus more or less deep, situated just in front of the tragus, and called a fistula. They are mere cul-de-sacs, or may communicate with the tympanum, and are thought to result from non-closure of the first visceral cleft of early foetal development. If thought desirable, they may be obliterated by cauterizing the lumen.

There are acquired deformities of the auricle from faulty ways of wearing the hair, veils, bonnets, and caps, which should be a warning to mothers and doctors. I saw a gentleman with large sized auricles, which projected directly outward from the side of the head, so that the anterior surfaces looked directly forward. The effect in both front and back view was very ludicrous.

The auricles may be made to stand out more from the head or to lie closer to it, by the judicious use of elastic pressure and a proper arrangement of the head dressing, during the early plastic period of infancy.

Erythema of the Auricle.—This condition lies between the ruddy hue of the auricle, which is said to result from a person's talking about you, and that of true dermatitis, and is caused by cold, pressure, friction, and injury. It is a simple hyperæmia of the organ without pain or swelling. Restoration to a normal condition may soon succeed, or it may develop into a more serious affection, as eczema or erysipelas. When it occurs upon the posterior surface of the auricle and the mastoid, it runs into Intertrigo, which may depend upon local irritation, constitutional

disturbance, or temporary paresis of the cervical sympathetic ganglia.

Treatment.—The physician is rarely called to treat such a trifling affection; the diet should be regulated, and the proper performance of the vegetative functions secured by appropriate medication. A soothing local application may be required, as sweet almond oil (*Ol. Amygdalæ dulcis*), cold cream (*Ung. Aquæ Rosæ*) or quince seed mucilage (*Mucilago Cydonii*). Apis, Arnica, Arsenic, Belladonna, Lachesis, Pulsatilla, Rhus, and Sulphur should be compared for internal medication.

Erysipelas of the Auricle.—Erysipelas is dangerous when it occurs about the head, and in the auricle it is no exception, as it may extend into the meatus and thus reach the brain. It is caused by cold, bites and stings of insects, traumatic injuries, and extension from contiguous tissues. There are the usual symptoms of chill, fever, headache, and constitutional disturbance. The auricle becomes stiff, deep-red, shining, and swollen; there is itching and burning, with exfoliation of cuticle, and, sometimes, crops of vesicles and small blisters. In severe cases, abscess may form in the subcutaneous cellular tissue of the auricle, as in the phlegmonous erysipelas of other parts, and the pus must be evacuated early to prevent distortion of the organ. The hearing is generally somewhat impaired. If the disease extends into the canal, it may leave a chronic dermatitis. If the membrana tympani and tympanum are invaded, an acute inflammation results in considerable damage to the auditory apparatus, and it is not without danger to the brain.

Treatment.—The patient should have good nourishing food; a moderate quantity of wine, if much depressed, and be kept quiet and comfortable. Notwithstanding the warning of some authors against cold applications to the ear, I would recommend the employment of cold slippery elm (*Ulmus fulva contusa*) poultices to the auditory region in erysipelas, as the mass soon becomes warm; but the meatus should be closed by cotton. If the cold poultice causes more than momentary chilliness, apply a warm one, and renew it as often as necessary to keep the auricle moist and comfortable.

Another application that has proved beneficial is the blue-clay

dressing of Dr. Hewson. Common blue clay is baked in an oven, pulverized, and passed through a fine sieve. Make a soft pultaceous mud of this by stirring in water, spread it upon strips of muslin, and apply all around and over the auricle. Renew the dressing as often as it becomes dry. I have seen this application have wonderfully good effects, not only in erysipelas, but in many other cutaneous diseases, during my walks with the distinguished surgeon in the Pennsylvania Hospital. When the dressings are renewed, the parts should be washed with warm water, and the meatus carefully cleaned of foreign particles.

Some few cases will not tolerate these dressings, but are improved by the application of cold cream, or by dusting with fine starch. Every case is a law unto itself. If an abscess forms, it should be opened freely, care being exercised not to cut the auricular cartilage.

There are no special symptoms about erysipelas of the auricle to call for a different treatment, than for the disease elsewhere. If it occurs with headache at the climacteric, Apis and Lachesis may prove valuable. Apis is indicated by sharp pains and oedema. Aconite is sometimes appropriate in the early stages, but Belladonna suits most cases better. Arsenicum, Rhus, and Sulphur are among the most valuable remedies, and Bryonia, Cinchona, Ferrum, Graphites, Hepar, Pulsatilla, and Phosphorus are occasionally indicated. The action of Apis and Rhus is sometimes very gratifying.

When the erysipelatous inflammation extends into the auditory canal or the tympanum, other measures may become necessary. Pain should be combatted by syringing the ear gently with hot water for some time, and by inflating the middle ear with the air-bag. The canal must be kept clear of pus, crusts, and scales, and the dressings may extend into it.

It may be necessary to incise the soft tissues of the canal, to relieve tension and evacuate pus. Effusion in the middle ear may call for paracentesis of the membrane and other proceedings, described under acute inflammation of the tympanum. In erysipelas it is desirable to be very conservative in surgical operations.

Frost Bitten Auricles.—The auricles get frozen frequently in our Northern latitudes, and must be treated carefully to avoid sphacelus. They are pale, stiff, cold, and insensible, and the patient may not at first be conscious there is anything the matter with his ears. The pathological condition varies with the severity of the freezing, from dermatitis to gangrene and sloughing.

Treatment.—The auricles should be rubbed gently with ice-water, and then the temperature of the water gradually raised until warm, and the parts become thawed. Then apply a lotion of carbonate of sodium (*Sodii bicarbonas*), ℥ss. to a pint of water, for a few hours, and give Aconite for a time. Spirits of camphor (*Spts. Camphoræ*), may be applied to the auricle about three times, at intervals of several hours, and then the parts painted with tincture of benzoin (*Tr. Benzoini*).

If there is severe pain, Belladonna may be useful. If vesicles form, and portions of the pinna look purple and slough, the parts should be covered by vaseline ointment on soft linen, and Arsenicum or Rhus given internally. Nitric acid is serviceable when the skin inflames, cracks, and bleeds, showing its impaired vitality. Agaricus is said to relieve itching, and cure the dry scaly condition of the chronic stage.

Other symptoms must be met according to general principles. Sometimes cartilaginous nodules form in the pinna, along with new cartilage, and are quite sensitive to the touch. When gangrene supervenes, charcoal poultices and surgical operations may be necessary. In order to diminish the sensibility of the frosted ear to cold, it is recommended to bathe it daily, during the summer, in a solution of alum (*Alumen*), ℥ss. to a pint of water.

Eczema of the Auricle.—This is a common disease of the skin, and is seen occasionally in the auricle and meatus, where its appearance and course are somewhat modified. It is seen most frequently in children and females; in those suffering from general debility, faulty nutrition, and innervation, and having a strumous diathesis. Among those thin, pale, half-famished children of the poor, who fill our sunless alleys and crowded tenements, the disease is most prevalent; but indolent and overfed persons living in luxury are liable to attacks from irritation of the alimentary canal, and subjection to local injuries. Some

writers think menstrual disorders, and the approach of the menopause are potent predisposing causes.

The exciting causes of the affection in the auricle are: too warm covering; uncleanliness; rubbing, scratching or picking the meatus; and using irritating remedies for ear-ache.

Acute attacks begin with heat, redness, a burning sensation, itching, and swelling. The inflammation spreads slowly, and may pass down the canal to the tympanum, and even along the Eustachian tube to the throat, where its character becomes changed.

An eruption of vesicles soon appears upon the auricle; these break early and pour out their sticky contents over the surface, where it dries and forms unsightly scales and crusts. If a crust is removed, the surface beneath will be moist, raw, and covered with bloody sero-pus, and this condition distinguishes eczema from many other skin diseases.

As the disease advances, the crusts break and serum is poured out freely to thicken the disgusting covering, which shows deep cracks, or else friction and accident rub them off and leave a raw, wet surface with bloody points. We must be careful to diagnose this condition from syphilis, which it somewhat resembles.

The auricle upon its anterior surface is very richly supplied with sudoriferous glands, and here the eczema is always more succulent and severe.

The posterior surface of the auricle is liable to affect the contiguous surface of the mastoid by friction and contact of the discharge, the skin becomes raw, and, unless great care be exercised to keep the parts separated by a cloth or powder, the two surfaces will unite. I operated upon a case of this kind in a little girl, in 1879, where the attachment was so complete, that there was merely a trace of a sulcus between the helix and the side of the head.

When eczema auris has become chronic, the pinna is stiff, thick, and misshapen from various cicatrices, and hypertrophy of the fibrous tissue.

Should the disease extend into the auditory canal, the inflammatory symptoms will be more decided. The skin of the canal is reddened, the periphery of the membrana tympani and borders of the manubrium of the malleus show increased vascularity, and

tinnitus, and slight deafness ensue. The epidermis of the parts is rapidly formed, elevated in vesicles, and exfoliated; the rete of the skin, and the periosteum covering the bone are thickened, and dermatitis blends with periostitis. The epidermic cells accumulate in the canal, the walls are covered by shreds and scabs, the membrane becomes dirty white and opaque, and the exudation of serum converts the débris into a cheesy fetid mass, which gradually fills the whole passage, and does considerable damage, if not removed frequently.

The tympanum sympathizes by hyperæmia and pain with the contiguous disease; the membrane may rupture, and the inflammation extend to the middle ear, Eustachian tube, and pharynx. Fortunately these complications of the auricular disease are rare.

Treatment.—The hygiene of the patient must be regulated, and any errors of diet corrected. The food should be light and easily digested, and acid fruits will prove salutary.

In the acute stage, the parts should be bathed with warm water and wrapped in cotton. When the parts become moist and excoriated, remove the crusts by picking, and washing with warm water, or apply a flaxseed poultice. Then bathe in diluted tar water (*Aqua Picis liquidæ*); in a solution of borax (*Sodii biboras*), ℥ij to a pint of water, or in one of German green soap (*Sapo viridis*), ℥ss. to the pint.

Should these measures fail to ameliorate, or should there be an excessive exudation of serum, making the side of the head filthy, in spite of the care exercised; it will be beneficial to dust over the parts with a powder of one part of oxide of zinc (*Zinci oxidum*) to seven of fine starch or powdered rice (*Oryza*). Lotions of tar water, diluted tincture of arnica, diluted tincture of cantharides, solutions of carbonate of potassium or sodium; glycerine, cod-liver oil, castor oil, vaseline, and oxide of zinc ointment have been extolled by different authors. I have used tar water, vaseline, and the zinc ointment in obstinate cases with much satisfaction, but I prefer the Hewson earth dressing to all other external applications. Clinical experience proves, that very many cases are made worse by oleaginous preparations.

In a very severe case, in the practice of Dr. L. H. Willard, of Allegheny City, Pa., where the disease covered the side of the

head and neck, after many external and internal remedies had failed to improve the condition, a solution of nitrate of silver (*Argent. nitras* gr. x, *Aqua dest.* f℥j), was pencilled over the raw surface every day, and brought about a speedy cure. This experience accords with that of Dr. Knapp, of New York City, who has reported a severe case cured with the silver solution, and extols it above every other remedy.

Whatever is done externally, the internal treatment must be persistent and thorough. Aconite, Apis, Belladonna, Cantharis, or Rhus will suit acute symptoms of certain cases. Conium is excellent for women with chronic eczema and menstrual difficulties. In my practice, Arsenicum, Calcareo phos., Graphites, Hepar, Mercurius, Rhus, and Sulphur have been beneficial and often curative in appropriate cases. Other medicines worth looking up are, Croton tig., Calcareo carb., Iris vers., Iodine, Kali hydriod., Lycopodium, Muriatic acid, Petroleum, and Pulsatilla.

When the disease extends into the auditory canal, the daily attention of the physician is necessary to remove the crusts and dirt by syringing and the use of instruments, in order, to relieve from irritation, and the obstruction to hearing. The warm douche will allay the itching and inflammation, and should be used several times a day. Push a strip of cloth wet with glycerine and water, or smeared with vaseline or zinc ointment, a little way into the canal, to soothe the raw surface. If the affection extends deeper, the complications must be treated according to principles laid down elsewhere.

Skin Diseases.—The external ear is subject to various other skin diseases. Pemphigus, Herpes, and syphilitic Roseola are frequent, and Condylomata of the auditory meatus have been seen occasionally. I had a case of syphilitic Psoriasis upon the outer surface of the auricle of a woman, which disappeared after a course of *Mercurius corrosivus*. These affections should be treated by the appropriate medicines, as they are when seen in other parts of the body, and complications met by the usual measures. One should be exceedingly careful to cleanse instruments in hot carbolized water, after dressing any purulent ear disease.

Furuncles.—Circumscribed inflammations of the subcutaneous cellular tissue of the auricle or canal are denominated boils. They are usually indicative of improper diet, and imperfect assimilation. They occur upon the auricle or in the cartilaginous portion of the canal, upon the posterior and anterior walls; sometimes one follows another in rapid succession, and so-called epidemics have been recorded. They are frequently excited by pus coming from middle ear disease, and by astringent and irritating washes, and are occasional complications of eczema.

The most common kind met with in practice are small, hard, red, and painful, especially, if they occur in the canal. The pain is dull, with occasional throbbings and sharp dartings, and is made worse by moving the auricle and the lower jaw. The tumors ripen slowly, and may undergo resolution by absorption; but usually they form a dull gray apex, break and discharge pus and mortified cellular tissue called a core; they disappear without leaving much trace. Others are large, cause considerable swelling and great pain, and destroy the symmetry of the parts.

They may be distinguished from osseous tumors by the acute symptoms, the location, and rapid increase in size. Sometimes the membrana tympani becomes very red and swollen, but the history will differentiate this from idiopathic myringitis.

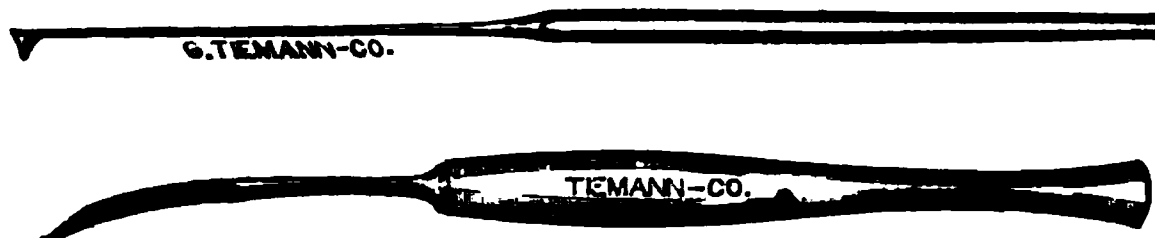
Upon the auricle, furuncles are manageable, but in the canal they often close the opening, induce deafness and noises, cause sympathetic swelling in the tissues and glands outside, and are accompanied by long, heavy, lasting pain. There is some febrile reaction, and there may be headache and grave cerebral disturbance. I have known swelling just inside the meatus to close it, a furuncle to break inside this, and the confined pus to press inwards upon the membrana tympani, so that severe pain, tinnitus, and vertigo persisted, in spite of the use of hot douches and poultices, attempts to dilate the canal, active inflation, and the administration of Aconite, Belladonna, and Hepar. A free incision of the canal over the seat of the phlegmon relieved greatly, and Kali hydriod. brought about a cure. Sinuses sometimes remain in the wall of the canal, and granulations spring up at the opening and form polypi.

Treatment.—Belladonna aborts boils if given early. Touching them with a drop of pure Carbolic acid often does the same.

Hepar will sometimes repercuss a threatened swelling, or failing in this, will promote ripening. Mercury is useful for very hard sluggish swelling with considerable pain. Silicea may be needed later. Carbo veg. is valuable in gross habit of body with gluttony.

A poultice of flaxseed meal (*Lini Farina*) should be applied over the auricle when it alone is affected, and a conical poultice in cloth pushed in the canal, if the canal is the seat of the swelling. In either case, the whole aural region may be covered with a poultice, as the danger of injuring the membrana tympani, or promoting the formation of polypi by their use is exaggerated. I have employed them for six or seven days together, and have never yet seen a membrane injured, nor a polypus formed by their use. Warm douches are very agreeable, and cleansing the canal with cotton on the holder, if there is discharge, may be necessary. The pus must not be permitted to remain deep in the canal and upon the membrane, but all the white shreds and epidermic scales must

FIG. 66.



FURUNCLE KNIFE AND CURVED BISTOURY.

be cleared out daily. Steaming the ear is a pretentious and troublesome way of applying heat and moisture, but is excellent when the patient is nervous, and the pain is violent and deep within the ear. A pledget of cotton wet with glycerine and pushed in the meatus will frequently allay severe pain from a boil in the canal.

If it is possible to determine the nodule of infarction, and it is indolent, and will not yield to medicines in a reasonable time, I think it good practice to split it entirely through with a curved bistoury or furuncle knife, when it will disappear promptly; the parts should be illuminated well by the head mirror during the operation. The pain from the cutting is endurable, it does not last long, and is more than compensated by the relief from the days of nursing a troublesome customer. The bleeding and con-

sequent relief of the congestion often prevent the occurrence of secondary boils.

If the furuncle is opened when its apex is formed, or it breaks spontaneously, it is well to squeeze out the pus and core of the gangrenous cellular tissue. Spontaneous rupture of a furuncle and discharge of pus does not always relieve pain. It is then advisable to make an incision through the swelling down to the cartilage and bone, in order to insure relief from pressure, and a free discharge.

When there are symptoms of deeper trouble, inflation must be practiced once or twice a day. This generally disappears after the subsidence of the furuncular inflammation.

Aconite and Belladonna are frequently indicated early; Hepar is a prince among remedies for these pests. Arnica has the reputation of breaking up the furuncular diathesis. Arsenic, Nitric acid, Sulphur, and Phosphoric acid are recommended for the same purpose. Granulations sometimes form at the seat of the furuncle, and should be touched with a solution of nitrate of silver, x grs. to an ounce of water; a mercurial ointment (*Hydrarg. oxid. rub. gr. v, Ung. Vaseline* ʒss.) is a good application to granulations. A course of sulphurous or alkaline baths will be agreeable, and of excellent hygienic value.

Anthrax.—Anthrax, or carbuncle, sometimes forms in the auditory meatus, causes terrible suffering, endangers the integrity of the hearing, and threatens life itself. It consists of a thick, boggy swelling of the skin and cellular tissue, ending in sphacelus of connective tissue, and diffused obstinate abscess. It appears as a very painful bluish swelling, which extends laterally, with no effort towards a conical elevation as in a furuncle. There is considerable constitutional disturbance, indicated by fever, restlessness, anxiety, and depression. The disease is a sign of depraved blood and lowered vitality, and the adynamia of the patient will enable one to diagnose it, when it occurs in the auditory meatus, more than the local symptoms, which at first cannot be distinguished from those of furuncle.

The swelling becomes greater, the pain terrific, the auditory meatus closed solidly, and delirium with grave cerebral symptoms occurs. The subcutaneous connective tissue undergoes sphacelus,

owing to the deprivation of nutrition by the violence of the exudation, spots in the skin give way from the same cause, and pus escapes from several openings. The discharge of purulent matter, blood, and shreds of dead connective tissue goes on sluggishly, until the tension is relieved, the boundaries of the infarction are reached, and restored constitutional vigor stops the destruction.

Treatment.—The early stages of anthrax are so similar to those of furuncle, that the treatment recommended for the latter affection should be first employed. The aural region should be kept covered by a warm flaxseed poultice, but a hot hop poultice (*Humulus*) saturated with laudanum (*Tr. Opii*) should be substituted when the pain is severe. The strength should be maintained by the most nutritious food, and frequent doses of milk punch.

The centre of the swelling is burned out with caustic potassium (*Potassii hydras*) by some practitioners; others recommend hypodermic injections into the tumors of a solution of carbolic acid (*Acidum Carbolicum*), grs. x to an ounce of water. Two or more deep incisions through the swelling should be made parallel and along the auditory canal, free bleeding encouraged by washing the parts in warm water, and a poultice then applied. Other incisions ought to be made, if the first close up, and the symptoms grow more violent, and the region should be frequently washed with warm water.

Aconite, Belladonna, or Hepar sulph. calc., are useful early in the disease. Arsenicum is a valuable remedy, particularly, in cases characterized by severe paroxysmal pain and asthenia. Apis and Lachesis are highly lauded by some practitioners. Nitric acid is considered a good medicine for the affection. Phosphorus and Secale corn. are recommended when grave cerebral symptoms supervene early in the attack. Carbo veg., Mercurius, and Silicea have their advocates. Cinchona or Quinia sulph. may be administered to the depressed and feeble, and Ferrum phos. is both nutritive and stimulating to such patients.

It may be necessary to give the patient a few doses of Morphia (*Morphiæ sulphas*), if the pain is violent, and does not yield to the other measures. Chloral (*Chloral hydrate*) is rather preferable to Morphia, when there is much cerebral congestion, and it

may be administered to an adult in x grain doses, every hour, till relief comes. If the inflammation extends to the tympanum, the complications should be treated according to directions given elsewhere.

Abscess.—Inflammatory affections about the ear result frequently in abscess. Disease of the tympanum or of the mastoid cells, frequently causes an abscess behind the auricle, called post auricular abscess. This sometimes becomes as large as a pigeon's egg, and makes the auricle stand out at a right angle to the side of the head.

The glands in front and below the ear become swollen and tender, during aural and throat diseases, and sometimes soften and form abscess. When in front of the auricle, they are seldom serious. A very formidable abscess occurs occasionally beneath the sterno-cleido-mastoid muscle, below the mastoid, either from infiltration of pus from a carious temporal bone, or from obstruction of the mastoid vein outside the skull, in the mastoid, or at its entrance into the lateral sinus. In the latter event, the whole side of the neck becomes swollen, boggy, and hard, and grave constitutional symptoms coexist.

In a case which I saw in consultation with Dr. H. W. Fulton, of Pittsburgh, Pa., there had been a mild acute inflammation of the tympanum with discharge of pus, and soon afterwards the neck began to swell. The lady had had careful nursing and concentrated nourishment, and poultices and the appropriate medicines had been employed. The pulse was rapid and feeble, the skin cold and clammy, appetite lost, and mind despondent; there was a little pus in the meatus, but no obstruction to its flow outwards, and no signs of mastoid disease except the swelling below; the whole side of the neck felt like a piece of bacon, dense, thick, and doughy. The patient was so weak she could not sit up long, and suffered from severe headache and vertigo. Fluctuation could not be detected with certainty, but an incision was imperatively demanded.

The patient was given an anæsthetic, a cut two inches long and one and a half inches deep was made down to the mastoid process, and, yet, no pus. There was no mastoid disease at all. Feeling certain there was matter below, the incision was made a

little deeper, just below the point of the mastoid, and at least half a cupful of pus came welling up from the muscular interspaces of the neck. The woman recovered rapidly with Cinchona, milk punch, and good diet. This case corresponds with some cases described in the *Archives of Otology*, and was undoubtedly an instance of occlusion of the mastoid vein, from pressure in the mastoid process, or slight obstruction in the lateral sinus from a thrombus.

Treatment.—A patient suffering from an abscess is in health below par, and must be fed well and, perhaps, stimulated somewhat by good wine and milk punch. Apply warm poultices over the swelling frequently, and when the presence of pus is diagnosed certainly, let it out by a free incision. The presence of pus may be decided in doubtful cases by puncturing the swelling with a hypodermic needle, and attempting to withdraw some in the syringe. When a large post-auricular abscess is evacuated, it is perfectly astonishing what a hard-walled, cupped depression results. After such an operation when I was younger, I feared the whole mastoid process was gone.

Abscesses about the ear are generally complications of ear and throat diseases, and the medicine must be selected according to the totality of symptoms. This cannot always be done, because certain ear symptoms may be absent in a pathogenesis, that otherwise fits the case well. A patient may be taking Mercurius or Pulsatilla, for a middle ear affection, when the swelling begins. If the latter is accompanied by symptoms which overshadow those of the ear, follow their indications and the characteristic symptoms of general disturbance, in preference to the aural ones.

Ear symptoms may call for Calcarea carb., yet, the supervision of a phlegmon with heat, redness, throbbing, and pain, accompanied by full, strong pulse, throbbing carotids, red face, glistening eyes, and severe headache will indicate Belladonna.

Belladonna suits more cases of abscess in the early stages, than any other medicine. Aconite is indicated, where there is much febrile reaction. Arnica or Cinchona should be given in marked debility. Bryonia is useful when the swelling is caused by exposure to cold, it is painful in the cold, and the throat and chest

symptoms of the remedy are marked. Hepar comes in very soon, and is very extraordinary in its action.

I treated a dentist in 1879, who had a very rebellious inflammation of the tympanum, which in spite of treatment remained purulent, painful, and threatening. At the end of six weeks, a hard tumor the size of a pullet's egg formed just below the ear. Poultices and Aconite were prescribed at first with little benefit, then Hepar, a powder four times a day, was ordered, and, in one week, the tumor had disappeared without leaving a trace, and the middle ear disease was also cured.

It seemed almost incredible that so large and hard a tumor could disappear completely without suppuration, after one package of powders of the third trituration.

Mercurius is needed when pus is forming slowly, and is sanious and unhealthy. Arsenic is capital for broken constitutions, and gangrenous tendencies. Silicea will prove valuable in chronic suppuration, and Sulphur is indicated, when struma is marked, and the discharge is profuse and illaudable.

Vascular Tumors.—The auricle and external meatus are sometimes the seat of vascular growths and swellings, which require treatment at the hands of the aural surgeon. They include simple angioma, cavernous angioma and othæmatoma.

Simple Angiomata.—These tumors consist of a mesh of arteries and capillaries, numerous, dilated, and tortuous, which are held together by a small quantity of connective and adipose tissue. Their color is generally violet or red, but is sometimes purple or blue, according to the condition and more or less stagnation of the blood.

The temperature of the skin over these tumors is increased, the blood can be mostly pressed out of them, but returns quickly. They form usually small, superficial, slightly elevated patches, tending to spread, and may develop into large tumors. They include nævus and telangiectasis.

Cavernous Angiomata.—These are composed of venous capillaries and veins, which are dilated into alveoli, or spaces, lined by endothelium. These alveoli communicate freely with each other, and the growths resemble the corpus cavernosum of the penis.

They are usually filled by venous blood, and form erectile, sometimes pulsating tumors, though they may remain flat, and be little elevated above the surface of the skin.

They feel like a bundle of worms; the blood cannot be pressed out of them entirely; they look blue, and frequently reach a large size. They include venous tumor, erectile tumor, and aneurism by anastomosis.

Treatment.—Many medicines are recommended for these tumors, but cures by them are rare. Aconite, Kali hydriod., Lycopodium, Phosphorus, Pulsatilla, Secale, and Thuja, whichever has the nearest corresponding symptoms, may be tried in appreciable doses, but operative procedure should not be too long delayed. Surgical measures are necessary in most cases to get rid of these blemishes, and upon so exposed a part as the ear one must choose the operation cautiously.

When the tumor is small, the meshes may be injected with fluid extract of ergot (*Ergotæ ext. fluid.*), or persulphate of iron (*Liq. Ferri persulphatis*) and pressure applied.

An excellent method is to heat a needle red hot and plunge it through the growth in different directions; or, if a galvano-cautery battery is at hand, introduce its needles, the *positive one first*, close the circuit, and sear the parts well. After either of these applications, one should poultice the part with flaxseed, or cover it with cold cream and a bandage.

Subcutaneous ligation is preferable, if the tumor is larger, contains much blood, or is elevated much above the surface by wide dilatation of the vessels.

Pass a strong, waxed silk ligature around the growth by a needle introduced under the skin, and pushed through its punctures twice, so that no skin be included in the circuit; then draw tightly and tie its ends quickly together. Or, one may divide the tumor into two parts by a double ligature carried deep beneath it, and then surround each half by its ligature in the usual manner. It is well to remove the ligature after forty-eight hours, in order to prevent too much sloughing and an ugly mark.

When the tumor is quite large, and wholly beneath the skin, it is neat practice to dissect up a flap over it, tie all the vessels,

and cut it out. This lessens cicatricial contraction, and leaves almost no trace of the operation.

Vascular tumors are not to be trifled with. A small one, if treated improperly, may furnish an obstinate and shocking hemorrhage. Treatment by caustic or by acupressure is, in general, not suitable upon the auricle, because it induces sloughing, and leaves rough, unsightly scars. In case the growth is quite large, covers considerable area, or involves important parts, a general surgeon should be invited to take charge; the sooner, the better, if the physician is at all timid, or a bungler in his use of instruments.

Othæmatomata.—Clinical observation and experiment prove that these curious tumors arise in most cases from disturbance of the circulation and nutrition of the ear, in sympathy with abnormal states of the base of the brain. Traumatic injury causes a few cases, as in pugilists and emulators of Pollux and Hercules.

Idiopathic cases have at first considerable congestion of the head and auricle, followed by rapid effusion of blood between the auricular cartilage and its perichondrium, with an elevation of the superimposed tissues. This happens generally upon the anterior surface, within the concha of either ear, and forms a circumscribed swelling. The tumor is hard and hot, of normal color or purple; it fluctuates a little upon deep pressure, and is accompanied by burning pains and a sense of weight. The disagreeable symptoms soon subside, and the tumor may remain indolent for weeks or months. The blood may be absorbed gradually, leaving the auricle not much injured; it may rupture its coverings spontaneously and cause great contraction and deformity in healing; or it may produce ulceration, sloughing, and gangrene of the auricle. These tumors occur frequently in the insane, and are seen occasionally in the healthy; they are much more frequently met with in men than in women.

Treatment.—Belladonna is the remedy *par excellence*, for the early stages of this disease; it is especially indicated by the disturbance of the circulation and the cerebral symptoms. Arnica is indicated by a bruised feeling, and hard, hot, shining swelling of the parts, with a tendency to gangrene. Arsenicum will be required for burning red spots, blisters, and sloughing, accom-

panied by general prostration. Hamamelis is suitable for stupor, congestion and tightness of the head, a venous hue of the swelling, and considerable prostration. Secale is better where the tumor is dry, cold, hard, and insensible, of a dark color, and free from offensive odor.

Local treatment in these cases is important. The weight of evidence is against evacuating the blood, as greater deformity results, than when spontaneous absorption takes place. Burnett advises punctures, only when there is great pain. Kirkbride recommends ice in the early stages. Ice or ether spray ought to control pain until it is relieved by yielding and adaptation of the tissues to the exudation. It would be well then, to bathe the auricle in dilute Arnica, and cover it closely with cotton. Should ulceration, abscess, or gangrene supervene, they must be treated as in other parts, protecting the ear, and saving as good an auricle as possible.

Other Tumors.—Almost any morbid growth that occurs in other parts of the body may appear in the external ear, but as their description and treatment are fully detailed in works of general surgery, I shall not say much about them.

Comedones.—These blemishes are seen in the concha; the ducts of the unusually large sebaceous glands here become inflamed and dilated, and their greasy contents mixed with dirt. They should be rubbed hard every day with a solution of caustic potash (*Potassii hydras*) ʒj to a pint of water.

Sebaceous Cysts.—These growths are caused by the inflammatory closing of the sebaceous ducts; the deep part of a gland becomes dilated and filled by the constantly increasing sebaceous secretion, which undergoes fatty degeneration, and resembles decomposing cheese.

Treatment.—The only certain way to get rid of these cysts is to open them freely, evacuate their contents, and cauterize the interior of the sac with acid, or else dissect them out altogether. One may give Arsenicum, Calcareo carb., Hepar, Iodinum, Kali bichrom., Lycopodium, Mercurius, Silicea, and Sulphur, according to the general symptoms for both of these affections, in order to improve the nutrition of the skin.

Tophi.—Tophi are rough, painful nodules sometimes found

under the skin of the auricle, in patients of a gouty constitution. They have been analyzed and found to be urate of sodium. The mineral body excites inflammation around it, and is generally inclosed in a nest of fibrous tissue. The appropriate constitutional medicines should be given as indicated. Simple cerate (*Cerat. simplex*), or belladonna ointment (*Ung. Belladonnæ*) applied to the hard, rough skin over the concretions, will relieve pain. If they become troublesome they can be cut out by even a novice in medicine.

Enchondromata.—These are new formations of cartilage. When in the auricle or meatus, they are generally connected with the true cartilage and perichondrium of the organ. They are of small size and seldom undergo any degenerative changes, but, in other parts of the body, they reach a greater development, and undergo fatty, calcareous, and ossific degeneration.

Treatment.—It is not proved that any internal medication has any effect upon these growths. They are hard and silex is hard, and so Silicea is given empirically. A rational treatment would be to paint them with tincture of iodine (*Tr. Iodini*), or apply an iodine ointment (*Ung. Iodini comp.*) about twice a week, for a long period. When the skin over them becomes irritable from pressure, cold cream or vaseline may be applied. When they are unsightly or cause inconvenience or pain, they may be removed by the knife, care being taken to adjust the flaps accurately, in order to diminish the scar and distortion.

Fibromata.—Fibromata are tumors composed of a network of white fibrous tissue, containing a few yellow elastic fibres. They are seen more frequently upon the auricle, than any other morbid growth, because ladies persist in having their ears bored for earrings by jewelers and others, who are ignorant of anatomy. In the lobe of the ear, at the seat of injury, the fibrous tissue undergoes hypertrophy, and produces tumors of variable size. I have seen them from the size of a pea to that of a hen's egg. They are often met with in negroes. I have an oval one, an inch in diameter, and two inches long, removed from the ear-lobe of a negress by Dr. C. M. Thomas, of Philadelphia, Pa., which looks so exactly like an unpeeled potato, as to have deceived many persons. The outside is reddish brown, the enlarged follicles resem-

ble eyes, and the cut face has that glistening appearance seen in potatoes, as well, as in sections of white fibrous tissue.

Treatment.—These tumors are so closely incorporated with the lobe, that it is probable they can not be removed thoroughly except by the knife. One may try medicines a reasonable time, as fibroids *have* been cured by medicines alone. I saw a fibroma the size of the fist, located in the right parotid region of a lad, that was removed by *Calcarea iod.*, prescribed by Dr. J. H. McClelland, of Pittsburgh, Pa.

Arsenicum, *Baryta carb.*, *Calcarea iod.*, *Conium*, *Kali hydriod.*, and *Silicea* are medicines, which promise much, and have cured some cases. They may be used in rational empiricism, when symptomatology does not point directly at the remedy.

I have tried some of these medicines in such cases for awhile, but my patients have either taken French leave, or I have resorted to operation before they had lost confidence and patience.

In operating upon the lobe, make a Λ -shaped incision with point upwards in the lobule, dissect out the tumor, and fasten the edges of the skin together with pins, and a figure-of-eight ligature wound over their ends. Remove the pins in three or four days, support the wound with adhesive plaster, and dress with simple cerate. If care is exercised, little deformity will result, unless the growth is quite large.

Fibromas in other parts of the auricle are rare; they are removed by rigid adherence to conservative surgery, in order to save as much of the auricle, and to distort it, as little as possible. Sometimes these fibroids return after removal, being of a sarcomatous character. They have recurred five or six times after extirpation, however, and have been finally cured. In rare cases of recurrence, malignant characteristics have developed, and life been lost by extension of the disease. For malignant tumors, clinical experience has demonstrated the value of thorough courses of *Arsenicum*, and of *Kali hydriod.*, in decided doses.

Sarcomata.—These tumors are fibro-cellular growths with malignant characteristics. One kind has a preponderance of round, nucleated cells, and is called round-celled; another is mostly composed of spindle-shaped, nucleated cells, and is called spindle-celled; and still another has such large succulent cells,

as to merit the name of giant-celled. These varieties of cells are frequently united in the same tumor, and they may be mixed with pigment and other kinds of normal tissue. These tumors are rare in the auricle, but arise sometimes in or beneath the parotid gland, and grow into the temporal bone and outwards as well. Several instances are upon record, where such tumors have sent processes through the Glaserian fissure, and invaded and destroyed the ear, causing death by cerebral complications.

These morbid growths are recurrent and malignant, and the resources of medicine, so far, have been of little avail in arresting their fatal progress. Their nature cannot be determined with certainty, except by examining a section of the heteroplast under the microscope; hence, the reports of cures of sarcomas by medicines, where the diagnosis rests upon coarse, clinical characters, are of doubtful value.

Treatment.—I have seen two cases of sarcoma materially improved by the continuous administration of Arsenicum iod., second decimal trituration, three grains, three times a day. By improved, I mean that the secondary tumors ceased to grow, and became somewhat shrunken, while the general health got much better. I have sometimes used Kali hydriod. in the same potency and dose, for a time, when the characteristic irritation of Arsenic has appeared.

Other remedies may be given according to the symptoms, and the judgment and experience of the physician.

Mercurius merits extended trial, since certain eminent German physicians have cured cancerous tumors with it, and hold the theory, that all malignant growths are remote effects of syphilis. Calcareo carb., Sulphur, and Teucrium are reported as having cured cases in the practice of the late lamented Dr. Carroll Dunham.

Arsenic, Aurum, Belladonna, Conium, Calcareo carb., Nuxvomica, Phosphorus, and Silicea are recommended by various writers, and should be given when their characteristic symptoms are present.

When the local symptoms form almost the totality, I think steady adherence to Arsenicum, Kali hydriod., and Mercurius will give the patient the best chances for life.

As soon as it is certain that a tumor is malignant, it is considered

good practice to cut it out, with all its immediately contiguous tissue. Sarcomas about the parotid and ear have not been cured by this procedure, but have generally returned and destroyed the patient. I leave the propriety of interference to our surgical writers; I would extirpate all suspicious growths before they become unmanageable from size, and while there is a reasonable prospect that the system is not contaminated.

Epitheliomata.—These tumors are composed of epithelial cells, aggregated in scales, finger like processes, and globular masses, lying upon the papillæ of the skin or mucous membrane, and penetrating into their fibrous substrata. Epithelioma is the only malignant disease that occurs primarily in the external ear. It affects the meatus as well as the auricle, and generally appears as a nodule or an irritated mole, upon the skin. This begins to exfoliate scales and crusts, and when they are removed a slight moisture, and some reddened papillæ are found beneath. The ulcer is usually shallow, and its edges are red, sinuous, and hard. Syphilitic ulceration occurs in this region, but can be diagnosed by the local appearances and history. The ulceration extends laterally faster than in depth, and ultimately destroys the auricle, and extends through the auditory canal and ear to the brain, if not arrested by treatment. The other varieties of cancer are so rare about the ear, that I refer to works of general surgery for their description and proper treatment.

Treatment.—The treatment of epithelioma should be radical and energetic. If the symptoms are markedly characteristic of any medicine, it should be tried faithfully. If not, as is frequently the case, the local symptoms furnishing the sole indications, Arsenicum iod., second decimal trituration, should be given, three grains, three times a day, after meals, until its peculiar pathogenic symptoms appear in a mild degree. If the growth does not begin to decline, continue the medicine in smaller doses, and wait a little while.

Should the disease remain stationary, or advance, try Mercurius iod. flav., second decimal trituration, in the same way. If it fails, give Kali hydriod., two or three grains, dissolved in considerable water, three times a day, until the disease is cured, or the patient is disgusted with the medicine, and has reason to be. It is ad-

visible during the trial of medicines to bathe the tumor with a solution of caustic sodium (*Sodii hydras*), gr. xx to an ounce of water, and to keep a compress wet with the same upon it whenever possible. This is said to favor exfoliation, and to arrest the penetration of the cells. Aurum, Calcareo carb., Carbolic acid, Hepar, Phosphorus, and Phytolacca should be studied, and may be tried awhile, provided the disease is not making rapid progress. Should this be the case at any time, the growth and morbid area around and beneath it should be destroyed by caustic potassium, nitric acid, nitrate of mercury, chloride of zinc, or the galvano-cautery, and the part poulticed until the slough separates; then dress the sore with carbolized glycerine or linseed oil (*Ol. Lini*) until healed. If the growth returns, repeat the process, or, if it is upon the auricle, amputate enough of this to remove beyond the shadow of a doubt all the outlying cancer cells.

When the disease has extended far into the auditory canal, it should be treated with warm douches, poultices, anodynes for severe pain, and one of the medicines mentioned above. If these measures are faithfully followed, the physician will have done all in the power of man to save his patient.

Injuries.—The auricle is subject to contusions, lacerations, and various wounds, which should be treated upon general principles. Arnica, Calendula, Camphor or Alcohol, diluted by water, make good local applications. It is better in repairing damages of the auricle to use interrupted sutures and pins, with collodion covering, instead of adhesive plaster, as the latter is difficult to apply to the uneven parts, and does not keep in place well. Sutures should go entirely through the auricular cartilage if necessary, as they do no serious harm.

The commonest injury of the auricle is cleft lobule, from the tearing out of ear-rings. The edges of the cleft and ends below should be pared, leaving the paring of one side attached below for a flap; the cut surfaces should be placed in apposition, the flap placed across the cleft and over the other end of the lobule, and the parts united by interrupted sutures upon both surfaces. Union will be speedy and the result so good, that few persons will ever know that anything has been done.

Sometimes the auricle is attached to the mastoid, owing to neg-

lect during the healing of a severe eczema, or the contractions of a burn.

I operated upon a child, having from the former cause the auricle, even, to its helix firmly united to the mastoid by dense fibrous tissue. Dissection was carried down to the cartilage of the inner part of the concha, and fibres of the attollens and retrahens muscles were cut. The dressings were appropriate, and kept the auricle away from the head, yet, the cicatrix finally drew the auricle back until it was nearly in as bad a position as before. I think it would be better in such cases to swing a narrow flap of skin from outside the region into the sulcus behind the auricle, that contraction may be distributed where it will do less harm.

It should be remembered that auricles entirely cut off and cold have been attached by sutures, have become gradually vitalized and united, and have served as good ears. In all large incisions of the auricle, the edges of the wound must be closely fitted and well sutured, and the auricle kept wrapped closely in absorbent cotton for many days.

The lobule is sometimes much elongated from habitual pulling, and from wearing heavy ear-rings. It may be shortened without danger. In the few cases where auricles have been entirely removed, it seems not to have injured the hearing much. Plastic operations are useless for making an auricle, and artificial ones are now made very beautiful and deceiving.

Burns over the auricle, mastoid, and in the meatus occasionally cause hyperæmia and middle ear disease. The Carron oil, one part of linseed oil to two parts of lime water, is next to the blue clay treatment, the best application for burns; Camphor in oil of Chamomile, gr. x to an ounce, is also useful, in relieving pain and hastening healing. These applications are far superior to the Cantharides and Urtica urens treatment, which some practitioners advocate strenuously.

Fracture of the Auditory Process.—A blow or fall upon the head is followed sometimes by a discharge of blood and serum from the auditory meatus. Blood may come from a simple rupture of the membrana tympani, but if it is followed by a discharge of serum, it is pretty good evidence of a fracture of the petrous portion of the temporal bone. This may occur from vio-

lence to the lower jaw, by which its condyle in upward movement crushes the lower wall of the external auditory canal, and the fracture extends into the deeper parts. This auditory process, forming the posterior wall of the glenoid fossa, is absent or defective in childhood, and becomes quite thin and fragile in old people from friction of the condyle, especially, if they are toothless. The accident is rare, and it is to be wondered at, when fractured jaws are so common.

Treatment.—When called to treat a fracture of this region, wash away the blood clots by a syringe and cold water. If the bleeding is copious, and ice water does not stop it, pack the canal with styptic cotton, or common cotton moistened and rolled in Tannic acid, and confine it by a bandage. After the bleeding ceases, cleanse the canal with warm water and the fountain syringe, wipe it out carefully with cotton on the holder, and examine by reflected light. The lower canal wall will be seen projecting into the lumen, and presenting an opening, through which ragged or loose bone can be felt with a probe; the movements of the lower jaw will be very painful.

The speculum should be worked gradually in, and the membrane examined. If it is intact, it is probable the petrous bone is not fractured. If torn, and blood or serum oozes through the rent, it is almost certain the petrous bone is fractured, even, if cerebral symptoms are not marked. The lower jaw should be fixed by wiring the teeth together, and by bandages; the canal pushed into position if possible, and the ear kept clean by warm douches. The suppuration should be guided to healthy repair, and sequestra should be removed, incising the canal when necessary. Symptoms should be treated as they arise by appropriate medicines.

Fractures of the canal are not dangerous, though the articulation of the jaw is sometimes roughened; those of the petrous portion of the bone are in most cases fatal.

Persons have been stabbed and shot directly in the auditory meatus. A man received a bullet in the meatus, which was found buried in the anterior mastoid cells; it was extracted and the patient recovered.

Foreign Bodies.—Foreign bodies in the external auditory

canal, are of frequent occurrence, especially, in children. They may be fluid, semi-solid, or solid; mineral, vegetable or animal. Some originate within the canal, others are introduced from without.

The symptoms vary from slight uneasiness to atrocious pain. Itching, heat, throbbing pain, tinnitus, and deafness are common symptoms. They sometimes cause frontal headache, lateral neuralgia of the head and neck, nausea, vomiting, cough, convulsions, and insomnia.

Among those things originating within, are: fluid blood and pus, epidermic scales, glove-finger epidermic casts of the canal, epithelial plugs, hardened cerumen, loose hairs, blood clots, inspissated pus, exfoliated bone, the *aspergillus* fungus, and maggots.

A child that I was treating for mastoid caries and middle ear disease, had a sudden stoppage of the canal, which could not be remedied by syringing. I found and removed from the bony canal a piece of bone a quarter of an inch in diameter, rough and full of large cells, and evidently a mastoid sequestrum.

Foreign bodies from without are, fluids of different kinds, peas, beans, beads, buttons; pieces of wood, stone, and metal; worms, and insects of different species.

Foreign bodies in the ear usually cause abnormal symptoms, and these are more decided the nearer the substance is to the *membrana tympani* or *tympanum*. A foreign body from without may remain deep in the canal for years, and not cause any more important symptoms than deafness and tinnitus. One case occurred in my own practice. A girl, aged eleven years, had always (?) been deaf in the right ear. One day she had pain and itching in the ear, and was brought for examination. The auditory canal was filled with tolerably hard, dark cerumen, firmly adherent to the wall. After syringing and some manipulation, the material was removed, and enclosed in it was found a small bean, quite hard, and the color of burned coffee throughout. It had evidently been in the canal for years, as it was carbonized and preserved by the cerumen, and no one knew when it had been introduced.

Incredible as it may seem, a foreign body has remained in the

canal for sixty years without doing much damage, and this should be remembered by rough fellows, with inappropriate instruments, who think a foreign body in the ear must be removed at all hazards, and blindly venturing, do great damage to the ear.

In the *Archives of Ophthalmology and Otology*, a case is mentioned, in which a hard rubber eyelet, placed in the membrana tympani, slipped through, and remained in the tympanum for several months, the membrane healing and closing perfectly: Little trouble was experienced from the strange middle ear incubus, and it was later successfully extracted by incision through the lower part of the membrane. A body may get into the tympanum, if the membrana tympani is destroyed; it may pass through the membrane by ulceration or violence, or an incautious physician may push it through, perhaps, destroying the membrane by his ill-advised attempts at removal. Things usually pass into the tympanum through the external meatus and the membrane, but objects have reached it through the Eustachian tube. There is a case upon record of a barbed wheat-head having passed through the Eustachian tube and out of the external meatus, after great suffering. A barley-corn, straws, pieces of bougies, and other things have been forced into the Eustachian tube, but not far enough to reach the tympanum.

The common round worm, *Ascaris lumbricoides*, has been found engaged in the Eustachian tube, but from some cases reported by reliable medical men, it seems they sometimes continue their journey, and escape by the external auditory meatus.

Dr. L. W. Reynolds, of High Wycombe, Eng., reports the following astonishing case, in the *London Lancet* for December, 1880.

"On March 3d, I was called to see a woman, aged 35 years, three or four months advanced in pregnancy. She was in a low nervous state, and had been suffering since Christmas from nausea and vomiting. About two weeks before, she had vomited several round worms, and about the same time, suffered severely from dyspnoea, and intense pain in the chest and abdomen. Shortly before my arrival, she had vomited two, and three more were discharged from the nostril, her nose bleeding first for three hours.

"I prescribed four grains of Santonine powder, to be taken at bed-time: after taking which, four worms were passed per rectum for the first time. The santonine was followed next morning by fifteen grains of compound scammony powder, when a great many more were passed per rectum. Three or four hours after taking the second powder, and having previously suffered all night from intense earache, a neighbor discovered a worm protruding from each ear, and both ears bleeding; the same day three others came away from the ears, two from the left, and one from the right. The following morning, March 5th, her husband drew another from the ear, and again another, on March 8th; this last was four inches long, with the diameter of a small goose-quill. A large number were, also, discharged each day by the bowel, making in all seventy-four.

"On March 10th, and again, on March 13th, my patient vomited a large quantity of dark blood, and complained at the same time of a feeling of tenderness in the abdomen for which I gave demulcents. On March 17th, in the evening, I was called to see her, and found her perfectly insensible, having been so since mid-day; the temperature was below normal, but with a fairly good pulse; she was roused again about midnight. The attack appeared to me hysterical. From this time she has gradually improved in health, but has had occasional attacks of diarrhoea.

"May 12th. For the last few days, blood has trickled from her ears and down her throat, which she coughs up. On examination with the auriscope, there is now, as there was in March, excoriation of either meatus, and a large perforation of both membrana tympani, but the sense of hearing is very little impaired.

"Remarks.—The history of this case appears at first almost incredible; but there can be no doubt the membranes were perforated by the passage of the ascarides. In addition to being vomited, some must have crawled up the œsophagus into the fauces, thence some found their way into the nasal passages, and others into the Eustachian tubes, perforating the tympanic membranes, and being discharged by the external auditory meatus."

Dr. C. S. Turnbull, of Philadelphia, Pa., in the course of correspondence with Dr. Reynolds, elicited the following additional facts: "The parasites were round, with five transverse marks,

tapering at either end, four inches long, the diameter of a large-sized Eustachian catheter, but this was in the dead contracted state. I regret I did not examine the parasites microscopically, but am certain they were *ascaris lumbricoides*.

"Three months previous to the passage of the worms, my patient suffered from deep-seated pain, and cracking sensations in the ears. This was relieved by a purulent discharge from the external meatus, and at the same time, a spitting up of a similar discharge. This had a very bad smell, and a bad taste; she has been bleeding from the ears at intervals up to the present time. With the otoscope can be seen in the right ear an oval aperture with puckered edges, and stained dark from the hemorrhage; a loud-ticking watch can be heard only close to the ear. As regards the left ear, evidence of perforation is still present, but the edges are in closer approximation than in the other."

Dr. John Dickson, of Bedford, Eng., in the *Lancet* for January 1881, referring to the above, says: "I have had lately a somewhat similar case under my care, in which the right tympanum (membrane) was ruptured, giving rise to a good deal of hemorrhage and slight deafness, the worms, three in number, escaping by the external meatus."

Dr. W. H. Bennett, of Philadelphia, Pa., furnishes notes of another remarkable case: "A. S., a healthy girl, was during the first half of her eighth year, subject to occasional slight attacks of earache. When eight and a half years of age, she had an attack of scarlet-fever, which was not followed at the time by any ear trouble. About four months after her recovery from the fever, she began to have occasional attacks of earache in the left ear, which continued without any treatment at the hands of a physician for five months. At the end of this time, she had a very violent attack, lasting several days. This was treated by instillations of warm oil and laudanum, and the external application of poultices. The pain was excruciating, and seemed to be increased the first day by the use of the oil and laudanum, but on the second day it diminished. It was on this day that I saw the patient for the first time, but having no speculum sufficiently small with me, I was unable to do more than make an examination of the external portion of the meatus.

Here there was no sign of inflammation, but the meatus seemed closed by swollen mucous membrane. During the whole of this day, there was great itching, and towards evening the child called to her mother, saying that there was something crawling in her ear. Before her mother came to her, she put her hand under the poultice and pulled something from her ear, which broke in two while pulling it. She then pulled the other half out of her ear.

"The two pieces were preserved and shown to me about twenty-four hours afterwards. They were parts of a lumbricoid, apparently about two and a half inches long.

"The child had no further trouble with her ear, and has not had since (nineteen months).

"The withdrawal of the worm was not accompanied by any blood. The ear was examined a few days afterwards by Dr. A. G. Heyl, who found no evidence of perforation.

"Under the use of Santonine the child afterwards passed a single lumbricoid per anum."

Dr. Turnbull's skepticism, in regard to Dr. Reynolds's case, led him to publish it, along with these others, and a valuable summary upon the subject of lumbricoid worms, in a Philadelphia journal, to which I would refer those who desire to pursue this subject further.* He believes that these parasites can pass through the Eustachian tube and tympanum, on account of their wonderful faculty of diminishing their size by elongating their bodies, and their power, frequently demonstrated, of insinuating and forcing themselves through small apertures and passages.

General principles will indicate the treatment necessary for such unique cases.

Treatment.—The physician, consulted for deafness or disorder of the ear, will often find the external canal occupied by things not suspected, even, by the patient, as in the bean case above mentioned. I once found a large, dead fly, macerating in pus, lying deep in the canal. He will be obliged to remove these obstructions to view, and the most of them being fluid or semi-solid can

* The Medical and Surgical Reporter, July 9, 1881; Philadelphia, Pa.

be washed out by a well directed stream from the syringe. Thus dirt, hairs, epithelial scales, pellets of cerumen, fluid and dried pus and blood, and small objects from without are removed with ease and safety.

The angular forceps, the hook and ear spoon, or the cotton holder, with a wisp of absorbent-cotton, moistened with glycerine and water, may be necessary to detach and draw out hairs and an obstinate particle, now and then, from the canal ; but, in general, instruments are not much needed, and should only be used gently under thorough illumination with the head mirror. No groping in darkness with instruments is allowable. Fill the hard rubber syringe, and, having pulled the auricle upward, and backward, inject a stream of tepid water forcibly into the canal, close against the upper wall at first, and then against the other walls in succession, in order to get behind, and not drive the substances further inward, and continue injecting until most or all of the offending material is removed.

There is generally a chink, or space, between one side of an object and the canal wall for the passage of water. After syringing awhile, it is frequently necessary to loosen scales, plugs, and cerumen from the wall, and this may be done safely with the angular or Pomeroy forceps and the ear spoon and hook, under good illumination.

In some cases, the syringe nozzle can be pushed in beyond the object requiring removal, when the water will get behind, and exerting much pressure outwards, will probably force out the foreign body. Dr. R. T. Cooper, of London, Eng., has invented a useful syringe for foreign bodies. The point of the nozzle is curved slightly, and the lumen for the discharge is close behind the point, and upon the convex portion. The point is introduced beyond the object, a light pressure keeps the crook against it and prevents its movement farther inward, while the stream flows past, and exerts its pressure from within outwards upon the object.*

* Clinical Lectures upon Inflammation and Other Diseases of the Ear. By Robert T. Cooper, A.B., M.D., Physician, Diseases of the Ear, London Homœopathic Hospital. Homœopathic Publishing Company, London, Eng., 1878.

In case of solid bodies, a stick with one end covered with warm glue may be introduced through a speculum and kept against the object in the canal until the glue is cold, and the object is fastened to it. Then the stick and foreign body can often be removed together. Small insects in the auditory canal are easily washed out. Large ones require a little extra consideration. The so-called earwig (*myriapoda*) rarely gets in the ears. I have lived several years in the tropics and subtropical regions, where they are quite numerous, and never met with an instance of one entering the ear. The beetle (*coleoptera*), and the bug (*hemiptera*) are the pests that crawl into the meatus, down the canal, and bumping their antennæ and heads against the membrana tympani, drive the patient almost frantic. The more one tries to get them out, the harder they hold themselves by their hooked legs and mandibles; they never go backward voluntarily, and cannot be made to do so, except by cast steel persuasion.

When an insect of one of these orders gets in the ear, the first thing is to kill it, as its movements cause severe pain, and may set a child into convulsions. Fill up the ear with olive oil or alcohol. The oil will clog the spiracles and asphyxiate; the alcohol will permeate and constrict the tissues, and produce the same result. Then use the syringe and warm water first, and this failing, extract the insect with instruments.

Dr. J. S. Boyd, of New Sheffield, Pa., sent me a patient from the country, with a dead bug that had been in his ear two days. He had suffered great pain, until he had drowned the animal in coal oil. A distressing tinnitus had continued since, with slight pain and heat in the ear. I found a beetle at the inner end of the canal, with his head pushed into the angle of the anterior lower wall and the tympanic membrane. Syringing failed, and instruments were necessary to detach and remove it.

Maggots have often been developed from eggs within a dirty suppurating ear. They are easily removed by filling the ear with sweet oil and syringing. A German physician reported a case in which he had tied a piece of fresh beef over the ear, and in a few hours removed the meat, containing all the maggots.

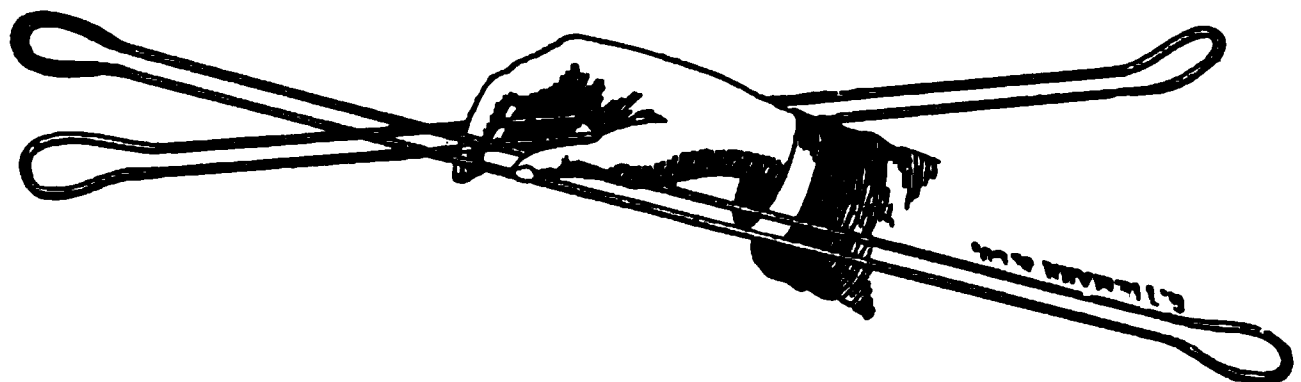
Suppose the canal is bloody, excoriated, and swollen from attempts of friends, and, perhaps, an incautious physician, to re-

move a foreign body, what is to be done? Order the ear syringed three or four times a day with tepid water, apply a light hop poultice for pain, give Aconite, Arnica, Belladonna, or whatever medicine may be indicated by the symptoms, and advise patience. The inflammatory reaction will soon subside, when the measures advised before will probably relieve the sufferer.

In these cases, and in those without any inflammatory symptoms, should persistent syringing and ordinary instrumentation not relieve, an aural surgeon should be called, who, with greater experience and a specialist's set of instruments, may make further trials. A number of very fine steel probes, with one end bent at a right angle very short, are very useful for extracting objects presenting angles and depressions.

A hard foreign body rarely fits the canal closely, there is a gap somewhere around the periphery through which one of these slender probes may be passed on the flat, the crook can then be turned behind the object, and it moved outwards.

FIG. 67.



CROW'S FORCEPS.

Crow's forceps are sometimes useful. The looped ends may be worked beyond the foreign body and then closed around it, not increasing its thickness, and then withdrawn. I have often succeeded by these means, when usual methods have failed. The patient *must* keep quiet; a child should be etherized; excellent illumination by the head mirror is necessary, and delicacy of instrumentation a *sine quâ non*.

The use of instruments is justifiable, even, when the foreign body has reached the middle ear, *provided it can be seen*.

Attempts to remove objects from the ear without seeing them are unjustifiable, and have had the saddest consequences. The auditory canal and middle ear are too near the brain to be punched

at haphazard. In a very few cases, the syringe, forceps, hooks, and probes fail, and a button, bead, pebble, or bean defy all attempts at removal.

If the *membrana tympani* is perforated, powerful inflations through the Eustachian tube should be tried. In case of failure, introduce the Eustachian catheter and inject fluid into it, through the tube, middle ear, and external canal. In both of these ways, things have been forced out of the middle ear and auditory canal.

Should an object be frangible, such as a dry pea, or bean, and firmly fixed in position, I would recommend the use of the Bracket Saw drill, or the Dental Engine drill, to break it up, diminish its calibre, or furnish places for hooking, as in judicious hands such drilling is less dangerous than the removal of exostosis from the canal, now a recognized operation.

It has been recommended in difficult cases to detach the auricle from the canal just behind the concha, turn it forward, and then proceed with instruments to extract the offending body. One might do this for a dagger's point or a pistol-ball, buried in the bone; but not otherwise, as the artificial opening furnishes no more room for manipulation than the natural one, and the blood interferes with proper work, to say nothing of the patient's sufferings.

If the foreign body can not be removed by any of these measures, leave it in, and keep the case under observation, till some future day, when it will come out, perhaps, from the simplest measures. Remember the numerous instances upon record, where various things have remained in the canal and, even, the middle ear for a long time without doing serious damage.

I know transatlantic authors teach the use of the syringe almost exclusively for foreign bodies, and that "all instruments are full of danger." This is good advice in general, but I would recommend the use of instruments, in removing foreign bodies, to supplement the syringe, and to supplant it, as good judgment shall dictate.

Ceruminosis.—This disease occurs in youths and adults and is rare in children. It affects the clean and comfortable person, living at ease, as well as the mechanic, exposed to the dust and dirt of workshops and mills. It seems to be more frequent in

the bilious, than in other temperaments, and is often symptomatic of tympanic disease.

Normal cerumen is composed in 100 parts, of 10 parts of water, 26 of fat, 52 of an oleate of potassium, and 12 of insoluble organic matter, containing a little carbonate of calcium and sodium. The cerumen of the ear is a mixed product of ceruminous and sebaceous glands, with epithelial debris and dirt. When the secretion of cerumen is increased above the normal, or it is unhealthy in its composition, its removal by desiccation, contraction, and falling out of the meatus, aided by movements of the jaw, as in health, does not take place rapidly enough to relieve the ear, and it accumulates in the canal. The accumulation is usually slow, but may be very rapid. It forms a homogeneous mass, or an aggregation of several layers. The mass may fill the lumen of the canal; become augmented by dirt, hairs, epithelial scales, and fibres of linen from the towel; work inwards toward the membrana tympani, and, perhaps, take an impression of it.

It causes a stopped-up feeling in the ear; cracking sounds, sometimes, when chewing; an itching and fulness in the canal; distressing tinnitus, often, by its pressure inwards upon the membrane and chain of bones; vertigo, sometimes of years' duration; dry, apparently causeless cough; dermatitis of the canal with thickening, and is accompanied by deafness and occasional pains.

The patient scratches the meatus with his finger, a match, pin, or pencil, and causes thickening of the skin lining. He can frequently improve his hearing by actively shaking a finger pressed in the meatus, as the cerumen is often displaced, leaving a passage down to the membrane. A passage may exist to the membrane when the canal is nearly full of cerumen, when a movement of the auricle or jaw may close it, and thus bring on sudden deafness. Outside sounds are cut off and internal ones intensified, so that the cooing rush of the carotid artery current is heard, in sounds synchronous with the pulse.

When the wax is hard, and presses much upon the membrane, it produces atrophy of its membrana propria, ulceration of its other layers, perforation into the tympanum, the development of polypi, and a long array of complications; it has been known by pressure to cause absorption of part of the bony canal. The

cerumen does not always take the shape of a plug, but may be pushed into various shapes and positions by attempts at relief. It may cover the membrana tympani and the walls of the canal like a coat, hard and difficult to remove, and sometimes to diagnose. Its lime, soda, and potash may form concretions of stony hardness. When the sebaceous glands are more active than usual, the cerumen is light-colored and sometimes fetid.

An excessive amount of cerumen occurs from hyperæmia of the canal from local irritation or inflammation; this congestion may be idiopathic, but it is oftener symptomatic of middle ear, and throat diseases. I have generally found catarrh of the tympanum, coëxisting with more or less localized hyperæmia of the lining of the canal; this induces slight inflammation of the ceruminous glands and hypersecretion.

The anatomical relations between the middle ear and the external canal are such, as to preclude the existence of disease in one, without some disorder in the other.

A narrow meatus in old persons, from relaxed auricle, and altered position of the lower jaw; a slit-like malformation with very tortuous canal; an excessive growth of hair in the meatus; and the presence of a tumor; all, by interfering with the spontaneous falling out of the cerumen, during movements of the jaw, frequently cause ceruminosis from mechanical obstruction. I have had several examples of obstruction and accumulation of cerumen from these causes. A gentleman and his daughter have narrow and crooked auditory canals, with ceruminosis and slight secondary middle ear trouble.

The age of the ceruminosis can be estimated by the condition of the cerumen. If it is glistening, soft, plastic, and of a light chestnut color, it has accumulated rapidly, and is of recent formation. If it is dull, grumous, hard, crumbling, and of a dark chestnut-color, or even black, and contains hairs, pellicles of epidermis and concretions of lime, it has accumulated slowly and is ancient.

Treatment.—The soft cerumen may be removed by warm water injections, aided, perhaps, by the spoon, or by the cotton holder, with a wisp of cotton twisted around it. The latter is necessary, frequently, when the cerumen forms a tenacious coat-

ing upon the walls of the canal, but it ought not to be wiped over the membrane. When particularly adherent and difficult of removal, it is best to use a solution of bicarbonate of sodium in glycerine and water (*Sodii bicarb.* gr. xx, *Glycerine*, *Aqua dest.* āā f3j). Incline the patient's head towards the opposite shoulder, fill the canal of the affected ear with this solution, and hold it in for five minutes every day. Continue this for several days, then syringe with warm water, and use instruments if needed.

Hard plugs of cerumen frequently adhere closely to the canal, and fill it from its cartilaginous portion to the membrane. One is often necessitated to remove these at one visit. Try syringing with warm water, then, if necessary, use the spoon, probes, and forceps to loosen and break up the mass. Illuminate the canal well, and be careful not to injure the canal walls. Syringe again forcibly, and use the soda and diluted glycerine if needed. By working with the syringe, the mining instruments, and the solvent, large masses of dense cerumen may be removed, and the canal cleared gently, safely, and thoroughly at one sitting.

It is generally better not to be particular to remove every particle at the first séance, as the lining of the canal is moist and irritable, and excoriations occur easily. When there is no necessity for haste, let the patient use the soda-glycerine solution once a day for a while, and return again.

A flake upon the drum head will often cause a continuation of tinnitus and other symptoms. After removing a plug of old dried cerumen, there is often found quite an accumulation of white pellicles between it and the canal, adhering more or less closely to the latter. They are epidermic exfoliations in plaques, and are frequently of a soapy feeling and nasty fetid odor. These should be removed with the forceps. If they continue to form, from hyperæmia or dermic inflammation, the aurist should brush the canal with spirits of camphor (*Tr. Camphoræ*), or a solution of nitrate of silver (*Argent. nit.* gr. x, *Aqua dest.* f3j), and continue the soda-glycerine instillation once daily at home. These measures will generally cure the skin disorder, but may not arrest the hypersecretion of cerumen. I have painted the canal with a solution of nitrate of silver (*Argent. nit.* gr. v,

Aqua dest. f℥j) with fair success. I have used the Phenol-Sodique undiluted, in the same way, three times a week, with the result of arresting, in some cases, the excessive glandular action. A mercury and vaseline ointment (*Hydrarg. oxid. rub. gr. xx, Vaseline, ℥j*) is a valuable local remedy for excessive production of the sebaceous glands, furnishing a pale yellow pappy cerumen. At the same time, I have given certain medicines mentioned below.

When the membrana tympani has become involved with the canal wall in a subacute inflammation, it has lost its normal color, and become somewhat hyperæmic and depressed. Whether this condition depends upon pressure of secretions in the canal or coexisting middle ear affections, the tympanum should be inflated for a week or two after removal of the cerumen, in order to relieve hyperæmia and push the membrana tympani and the chain of ossicles into proper position, and thus relieve the pressure upon the labyrinth, the resulting tinnitus, and other affections.

Cases of ceruminosis of not long continuance are very amenable to treatment, and unless there is some deeper complication, the recovery of aural integrity will be perfect.

Cinchona produces active hyperæmia of the whole auditory apparatus, and is especially useful in excessive activity of the ceruminous glands. I have used it extensively in this affection, and am satisfied it is one of the most useful medicines that we have. It is more adapted to adults, where the cerumen is dark, the temperament bilious, or there is a malarial cachexia. As the hyperæmia in the canal in most cases of ceruminosis coexists with congestion of the deeper parts of the ear and tinnitus, the relation of the medicine to such cases is readily appreciated.

Pulsatilla has proved curative in patients of leuco-phlegmatic temperament, subject to frequent catarrhal attacks, and with the cerumen abundant, soft, and yellow brown.

Arsenicum.—When the meatus is dry and scaly, the cerumen is dark and forms slowly, and there is deafness and subacute inflammation of the middle ear of long duration, Arsenicum long continued, will restore the ceruminous glands and lining of the meatus to healthy action, and benefit the tympanic affection.

Hepar.—In some cases, the sebaceous glands are more at fault than the ceruminous, and the accumulation in the canal is whitish

yellow, moist, and fetid. For this condition, there is nothing better than to give Hepar internally, cleansing the canal with Liq. Potassii upon cotton, and applying the mercury and vaseline ointment daily. Beyond these remedies I have nothing further to offer in this connection, but I assure my readers, that the abnormal activity of the glands of the external auditory canal can be arrested by persistent local and internal treatment.

Acute Dermatitis of the External Auditory Canal.—Besides the mild inflammation of the external auditory canal already described, there are others peculiar to the region, which require special consideration. Acute dermatitis, superficial inflammation of the canal, or external otitis, is a disease *sui generis*. It is often limited to the cartilaginous portion, but may affect the whole canal and the surface of the membrana tympani. It is caused by cold, affections of the throat, erythematous diseases, getting sea water in the ear, dropping in various kinds of lotions, scratching, picking, and tearing the skin by ear spoons, sticks, hair pins, and pencils, and by the development and growth of different varieties of a fungus called *Aspergillus*.

Its active period lasts from three or four days, to two weeks or more; it may become chronic, and continue for months or years, when caused by erythematous disease, typhoid fever, and parotitis.

The disease begins with heat, dryness, fulness, itching, burning, and slight pain in the external auditory canal. An ignorant patient will do almost anything to relieve the annoying itching and burning, and he scratches and tears with the first thing handy, a match or pencil, or he drops in some cure-all recommended by Mother Grundy, and thus aggravates the disease. Shooting pains, not very severe or persistent, now occur; the canal lining becomes swollen and very sensitive to the touch; the canal is diminished in diameter, especially, at its deep portion, so that the membrana tympani is shut off from view by folds or ridges; and there is slight fever and headache. When the osseous portion of the canal and surface of the membrane participate in the inflammation, the pain is more severe, and there is tinnitus, vertigo, and deafness. The glands of the canal pour out a soft yellowish-white mixture of cerumen, sebaceous matter, and serum, or of creamy pus sometimes showing blood. In some cases, the

sero-purulent discharge is quite free. The epithelium becomes soft, moist, and thick, and may separate *en masse* from the dermis, resembling dirty white paper. Sometimes little masses are syringed away, that are thought by the uninitiated to be wads of paper, which the patient has put in the ear and forgotten. Occasionally, dark pultaceous masses or dense fibrillated shreds, covered with black dots, cling tenaciously to the canal or membrane, and are removed with difficulty. They are composed of the mycelium and spores of some variety of *Aspergillus*, a kind of mould, which has either caused the disease, or become developed in the nidus of inflammatory debris, or in olive oil, dropped in for earache. When the disease is caused by the parasite, it is called Otomycosis.

If the canal is cleaned out and examined at this stage, the walls are found covered by a thin epidermis, that is pink in the cartilaginous portion, and cherry red in the osseous; the membrana tympani is of dull, diffused red, with vessels running upon it from the periphery, and a streak of them in the position of the malleus handle, but the process of bone cannot be distinguished, and the light triangle has disappeared. A perforation may exist in the membrane, and the tympanum be diseased primarily or secondarily to the disease of the canal, especially, if the patient has scrofula.

These conditions are generally present when the case has run several days without treatment, and the mixture of sero-pus, glandular exudations, and epidermic tissue has filled the canal and pressed inward against the membrane.

One must look sharp after granulations, polypi, and perforations of the membrane. The bony structure may be inflamed or in a condition of caries, though these are rare complications of simple attacks. In strumous constitutions, one may have grave lesions accompanying, which I shall mention later. In milder cases, where the exudation and exfoliation have not been so great, the osseous portion of the canal, and the membrane may be only a little hyperæmic, the pain trivial, the malleus and triangle plainly visible, and the hearing little, if any, affected. The disease resembles eczema somewhat, but differs from it in its exudation, and the absence of vesicular eruption and crusts.

The inflammation may subside spontaneously without treat-

ment and leave no sequelæ, but such a result is exceedingly rare. It has been my experience to find two distinctly defined morbid conditions of the auditory canal, clearly traceable to the external otitis; one resulting from mild attacks, and another from severe ones. Chronic Dermatitis of the canal is sufficiently expressive of one kind, and Chronic Adenoid Dermatitis of the other.

Treatment.—The very first thing to do is to clear out the auditory canal by a gentle and prolonged syringing, with a warm decoction of hops (*Humulus*). This will remove material that obstructs the view, and, perhaps, presses upon the membrana tympani; soothe the ear; and relieve congestion and pain. The canal should be dried out with absorbent cotton, and a little roll of muslin smeared with cold cream, be pressed in with a probe. This should be removed and the canal syringed with the warm hop tea, three or four times a day or oftener, if the pain or inflammatory products make it necessary.

When the pain is severe, a hot decoction of poppy heads (*Papaver*) may be used instead of hops. If pain is still persistent, put a grain of Morphia in a teaspoonful of hot water, and instill a few drops every fifteen minutes, or apply a hop poultice wet with laudanum over the ear.

Should the *Aspergillus* fungus be detected by the microscope in the discharges, and the disease seem to depend upon its presence, if the syringing does not destroy it entirely, as it often does, strong alcohol must be poured in the ear and allowed to remain a short time, or a solution of hypochlorate of lime (*Calcii hypochloras* gr. ij, *Aqua* fʒi) may be used instead. After the parasite is killed, go on as usual with the appropriate treatment.

Aconite or Belladonna, according to the indications, should be given freely in water. For an adult, put ten drops of the tincture in half a glass of water, and give a teaspoonful every hour or two, until the pain diminishes; then give it less frequently. The patient should be kept in a warm room, drink lemonade freely, and have the diet restricted in regard to meats. If tinnitus and deafness are marked, an inflation with the air-bag ought to be given, at first, once or twice a day. The membrana tympani should be examined closely for perforations, because

sometimes disease of the middle ear may be the cause of the external trouble, and an excoriating discharge pass outward through an obscure perforation in the membrane. Such cases require different treatment, which will be found described under Acute Inflammation of the Tympanum.

Perforations arising from the external disease demand more careful syringing and less of it. In case the osseous portion of the wall is not very sensitive nor much swollen, push a piece of absorbent cotton, smeared with cold cream, down to the membrane. This keeps the membrane clean and favors healing. In one case treated, the round perforation closed after two applications. This packing is often successful in closing the hole in the chronic stage. Small perforations of the membrane show a dark spot, a hole in the membrane, and darkness beyond, like the pupil of the eye. Large perforations permit the rosy and sometimes granular inner wall of the tympanum to be seen plainly. An increase of deafness and pain in the ear and side of the head is good evidence that the middle ear is attacked.

Perforation of the membrane may be detected, when it can not be seen under good illumination through a speculum, by inflating with the air-bag. If perforation exists, the air will hiss or whistle out of the hole. This can be heard, and the orifice found, by observing the membrane while the patient inflates by Valsalva's method.

Sometimes the acute dermatitis, instead of advancing inward, extends deeper into the cellular tissue; the canal walls and parts around the auricle swell considerably, and the case advances into one of phlegmonous inflammation. This requires poultices, incisions, Hepar, Mercury, etc.

Pulsatilla is an excellent medicine after the primary symptoms of an acute dermatitis have passed away. It is needed when the inflammation has invaded the middle ear and throat, and there is a true mucous catarrh, indicated by the light bland discharge from the ear and pharynx.

Chamomilla.—When the discharge is slight, the pain moderate, and the restlessness and irritability are out of all proportion to the aural affection, a few doses of *Chamomilla* improve the condition of the ear, and act like a charm upon the nervous system.

Hepar is useful in strumous constitutions, where the discharge from the ear causes an eruption of vesicles and pustules, and breaks in the skin do not heal readily, but incline to ulcerate.

Calcareæ carb. is occasionally indicated in scrofulous patients with marasmus, debility, great sensitiveness to cold, and liability to take cold easily.

The congestion, increased exfoliation of epithelium, and hypersecretion of the glands gradually diminish, if the canal is treated as detailed, and then syringing once a day with simple tepid water, and applying a fold of linen covered with cold cream will hasten the cure. Should this and internal medication not suffice, one may try a lotion of sugar of lead (*Plumbi acetat* gr. v, *Aqua dest.* fʒi), swabbed over the canal with cotton on the holder, which I have found an excellent stimulant to healthy action. This may be warmed and a little poured in the ear with a teaspoon, and allowed to remain several minutes before removal, but, in case of perforation of the membrane, this last method of application for obvious reasons is inappropriate.

When the wall remains hyperæmic, the hypersecretion and exfoliation moderate, along with too much moisture, a solution of nitrate of silver (*Argent. nit.* gr. x, *Aqua dest.* fʒi) should be applied to the walls with cotton or a camel's-hair brush, every day or two, till improvement is manifest. Persistence in the measures laid down will probably cure the disease, but should it become chronic, the further treatment must be sought under the chronic forms mentioned below.

These attacks are frequently indicative of imperfect nutrition, and where repair is not prompt, and the patient does not eat and digest well, I frequently prescribe a little of Speer's Port Wine, to be taken with the meals. I believe the use of wine in the treatment of some diseases both rational and scientific, and though my own habits are almost those of a teetotaler, I believe the influence of reformed drunkards in the cause of temperance has scared American medical men into intemperate abstinence from good remedies, which our transatlantic brethren find so beneficial and necessary in disease.

Chronic Dermatitis.—This disease of the canal is frequently a sequela of acute dermatitis, and of eczema, but may arise idio-

pathically from sympathy with middle ear or throat disease. I have seen this most frequently in the bilious and lymphatic temperaments. It is characterized by fulness, itching, and discomfort of the ear; the ear is sensitive to cold, and there is deafness, tinnitus, and hypertrophy, with exfoliations of the epidermis. The walls of the canal may show thin scales and shreds of epidermic tissue, and small particles of dirty white sebaceous cerumen adherent here and there, but mostly along the cartilaginous part, and at its junction with the osseous portion. Many of the epidermic shreds must be seized by forceps, in order to detach them, and this frequently causes bleeding and severe pain, owing to the congestion and hyperæsthesia of the canal.

The epidermis, dermis, and subcutaneous cellular tissue in some cases are considerably thickened, so that the canal is narrowed into strictures, especially, at the junction of the cartilage with the bone, and the surface has a hard, rough feeling, when a probe is drawn over it, much like that conveyed to the mind by dragging a lead pencil over the outside of a cloth-covered book. This true hypertrophy looks something like coarse yellow sand-paper, is most rebellious to treatment, and takes the name of Ichthyosis, or Pachydermatitis.

The membrana tympani appears about the same in the three stages of dermatitis; it is dirty white, dull, and opaque; the light spot is diminished, bisected, or obliterated; the malleus has a visible leash of vessels along its handle, and around the periphery of the whole membrane a false *arcus senilis* of epidermic thickening is perceived.

When tympanic disease without perforation coexists, the membrane may show a dull gleam of maroon color through its posterior half, and be depressed and, perhaps, distorted in various degrees.

When this disease is not treated at all, or is aggravated by the frantic attempts of the patient to stop the itching, with ear picks, pencils, etc., or by pouring olive oil or glycerine into the ear from time to time, an accumulation of morbid material occurs, and blocks the canal, so that the already impaired hearing is still further diminished; but the canal is very dry, and the product of the skin and glands usually desiccates, and shrinks, and seldom amounts to enough to act as a plug to the meatus.

Treatment.—Many works upon the ear do not deign to mention or to give any treatment for this common disorder, and some that do, reveal the poverty of the author's therapeutic resources. The condition of the canal, middle ear, and Eustachian tube should be interrogated carefully. Obstructions to a view of the membrane should be syringed away by tepid water, and pulled away by the angular forceps. The walls and membrane should be cleaned; sometimes, I wet cotton on the holder with glycerine and water, equal parts, and wipe them gently. One cannot be too gentle, because the membrane is always very sensitive, and both it and the canal lining are hypersensitive in the affection under consideration.

If the membrane is opaque and depressed, or there are symptoms of middle ear complications, inflation with the air-bag should be given twice a week, or daily, if the symptoms are active and important.

If the canal wall is hyperæmic, as it usually is, apply about twice a week, a nitrate of silver solution (*Argent. nit. gr. v, Aqua dest. f3j*) with a wisp of cotton, or a camels-hair pencil, to the whole diseased surface. This relieves the itching, and stimulates the skin to healthier action. In the interval of the silver applications, the patient may drop in equal parts of glycerine and water once daily. Vaseline is a better application, if the skin is thickened and roughened by hypertrophy, and not much congested. If there is true Ichthyosis, diluted Iodine (*Tr. Iodinii 3j, Alcohol 3iij*) should be painted over the thickened part about twice a week, and vaseline rubbed over afterwards. These local measures are necessary to effect a cure, and are all I can recommend from experience. No cotton should be kept in the ears, unless cold air causes considerable pain; then it should be removed as soon as the warm house is entered.

Hepar.—When the ears ache in the cold, and are very sensitive to touch, the membrane is opaque and thickened from slight inflammation of the tympanum, and the throat is frequently a little sore without there being any objective signs of it, I have found Hepar a most useful medicine. Inflation should be practiced once or twice a week, or oftener, if the Eustachian tube does not open freely. Dr. Cooper, of London, has cured anal-

ogous cases with Hepar, as recorded in his treatise, but I must say, that my observations upon this application of the medicine were recorded in my case books, a year or more before I had the pleasure of reading his individual experience. Confirmed by two independent observers, in numerous cases, the medicine rises to the rank of a specific.

Cinchona.—It has been repeatedly demonstrated that Cinchona produces hyperæmia of the auditory apparatus. Guided by its aural pathogenesis, I have used it often in chronic dermatitis of the canal, with rather active determination of blood to the walls, tinnitus of the ringing variety, slight pains and pulsations, and uncomfortable sensations about the head. The disease is quite prevalent in persons living in malarial regions, and some of the symptoms enumerated are periodically aggravated. I cannot say from experience, whether large doses of quinine taken for ague, or the malarial cachexia often apparent in the patient, is the cause of the disease in the auditory canal, but I do know, that Cinchona and Quinia sulphate are proved remedies in my hands for its cure. The medicine is the essential, the preparation used immaterial, but the quantity must be appreciable to cure this most persistent aural affection. It is astonishing how the grand characteristics of a remedy will sometimes describe a morbid condition.

Nux Vomica.—The disease under consideration occurs most frequently in dark bilious individuals, who are hypochondriacal, irritable, and impulsive. They have digestive troubles, flatulence, constipation, a muddy complexion, tendency to severe neuralgias, gouty pains here and there, frequent chilliness, and many of the symptoms detailed above. In such persons, Nux vomica strikes the mark in the centre, and, by improving the general health, and stimulating the vaso motor nerves of paretic vessels, cures chronic aural dermatitis.

Silicea.—When the skin has become thick and rough like hog's hide, and partially closed the canal, Silicea may be tried, but I have not had much success with it. If a stricture exists in the canal, it may be dilated by laminaria (*laminaria digitata*) tents, introducing a larger size every day. Too much should not be attempted at once; care must be exercised not to push the tent

against the membrane, and it must be removed for awhile, if the pain becomes severe. Besides the above medicines, for internal use, I have tried Arsenicum, Kali bichrom., Calcareo phos., and Thuja with not encouraging results, and several others as inter-current remedies for temporary conditions.

I believe careful attention to the local treatment, and the persistent use of one of the medicines mentioned will in most cases bring about a cure, but this may be hastened by improved nourishment, a trip to the mountains, and banishment of "carking care."

Chronic Adenoid Dermatitis.—This disease results generally from an acute dermatitis or eczema, but may occur from sympathy with middle ear affections. It is the variety of dermatitis seen in lymphatic temperaments, and the strumous diathesis. There is itching, fulness, tinnitus, and deafness, but pain is slight or absent.

The surface of the canal under the discharge is yellowish gray, or may be red, but it is not so much congested nor so sensitive, as in the preceding disease. Soft dirty-white shreds of exfoliated epithelium are found partially detached in places, others lie loose in the canal, mingled with soft, fetid, cheesy, grayish masses of sebaceous matter and cerumen, moistened by a small quantity of creamy pus. This stuff covers the walls with a pasty coating, accumulates in all the depressions, especially, at the attachment of the cartilaginous portion of the canal to the osseous process, and may fill the entire canal, excoriate and cause ulceration of the canal walls, and press upon the membrana tympani.

The membrana tympani may be dull, opaque, and thickened, but, if the disease has existed some time without proper treatment, it has more the appearance of a piece of muscle. The color is cherry red, irregular, and streaky. The handle of the malleus and light triangle have disappeared; the membrane moves very sluggishly during inflation of the tympanum or the suction of Siegle's instrument, and dull tinnitus and deafness are marked. With this condition the middle ear usually shows a slight inflammation, which yields rapidly to inflation, after treatment of the external disease has continued awhile.

The sebaceous and ceruminous glands produce their morbid

secretions very rapidly, and when this is removed frequently, the lining of the canal gets better very soon, so that I am inclined to consider the glands as the sustainers of the morbid condition.

Schwartz is unable to say whether there is hyperplasia of the glands, or degeneration of the glandular epithelium. The reason why the glands are more active in this affection, than in the previous one, is found in the diathesis of the patients, who are strumous, and have the well-known tendencies to glandular inflammation.

Treatment.—The above description will impress the reader with the importance of cleansing the ear often, and the administration of a medicine, which shall have a local action upon the ear, and a general influence against the diathesis.

The canal should be syringed and thoroughly cleansed once a day with equal parts of warm water and glycerine, and fragments of epithelium and pieces of the cheesy secretion, that do not come out with the stream, should be helped out with the cottoned holder, angular forceps, and ear spoon. If the wall is red and congested, a five grain solution of nitrate of silver may be applied, and a little cold cream be smeared upon the wall.

When there is little congestion, after the canal is cleaned, have the patient incline his head towards the side not under examination, fill the ear with tar water (*Aqua Picis liquidæ*), and leave it in five minutes. Then let the patient straighten up, catch the lotion in a cup, dry the ear with a towel, and smear over the canal with a little vaseline ointment. All the balsams and turpentine exercise considerable influence upon glands everywhere, and tar water used in this manner is a powerful adjuvant in diminishing excessive secretion of the auditory glands, and restoring them to healthy action. It exercises an antiseptic influence over the secretions, and seems to agree with the membrana tympani, as well, as with the canal wall. I have used it very frequently for cases of medium grade, and it helped to cure many of them.

In cases that resist this treatment, where the morbid secretion is sticky and difficult to remove, use a solution of bicarbonate of sodium (*Sodii bicarb.* gr. v, *Aqua* fʒj) as an injection, and wipe out the canal with cotton; then, if the membrane is intact, fill

the ear with a solution of sugar of lead (*Plumbi acetat* gr. v, *Aqua* f3j), leave it in a few minutes, then let it run out, and dry the ear. This ought to be done at least once a day.

For more severe cases, syringe with tepid water, and let the last injection be of tar water; then, after drying with a towel over the finger, pressed not too hard into the meatus, apply by a probe and cotton a good coating of mercurial ointment (*Hydrarg. oxid. rub.* gr. xx, *Ung. Vaseline* 3j), or (*Hydrarg. iod. rub.* gr. v, *Ung. Vaseline* 3j), all over the walls of the canal. This dressing ought to be done three times a week, or if the case is very bad, every day.

Ulcers should be wiped clean and have an extra dose of the ointment, and, if they do not heal, it may be necessary to touch them with a solution of nitrate of silver. Granulations sometimes spring up along the wall and must be touched with nitrate of silver solution, gr. xxx to f3j, or by the solution of subsulphate of iron (*Liq. Ferri subsulphatis*). If polypi form, extract them with forceps, or the Wilde-Blake Snare, and touch the bases with the iron solution.

If the membrane and tympanum are affected, as they frequently are, the air-bag inflation should be given mildly at every visit, and the throat treated once a day by a gargle of a heaping teaspoonful of salt to a pint of water.

I have tried many medicines internally long and faithfully in this disease, and am satisfied that they are impotent, unless the local measures are carried out energetically. There are only a few that I can endorse heartily, and these are more indicated by general than special symptoms.

Arsenicum iod.—This is a decided anti-strumous remedy, and exercises a salutary influence over the nutrition of the skin. There is roughness of the skin from scales of loosened dead epidermis, and little papules here and there in clusters. The auditory canal exfoliates many moist scales; the sebaceous stuff is not very profuse, but quite moist; the canal feels hot and raw, and the odor of the ear is decidedly unpleasant. If the material has remained long in contact with the walls, or its moisture oozes out of the meatus, there is excoriation, and may be ulceration. As the disease is deep-rooted and slow in leaving, one is apt to get out of

patience, but the doctor must stand it, if the patient can, and should be firm and persistent in his prescription.

I treated a case of several years standing, during three months, and cured one ear, but the other did not get any better. I changed my prescription for internal medicine several times for good reasons, but the ear remained about the same. After some months, I returned again to the original medicine, and the lagging ear was restored to health in about two months. "Be sure you are right, then go ahead," is as good for a doctor as for a locomotive engineer.

Cinnabar is a medicine of much value in adenoid dermatitis. It is applicable, when the sebaceous secretion is considerable, and the exfoliation of epidermis slight. There may be ulceration of the canal, but there is no burning sensation; the walls bleed freely when the scales are pulled off, or the canal is rudely touched by instruments, indicating a tendency to granulations. If ulcers exist, they feel raw and sore, and bleed, even, when wiped carefully. There may be a strumous or syphilitic taint in the system, and the deteriorated blood, passing through the glands, furnishes unhealthy pabulum for the abnormal secretion.

Calcareo phos. stands third in my estimation, as a remedy for the above disease. It is far superior to *Calcareo carb.*, and sometimes improves a variety in which there is considerable exudation of serum—a wet kind—that is almost odorless. It is particularly applicable to thin, pale, strumous children, with about equal quantities of whitish epidermic scales and sebaceous matter, moist, soft, and pultaceous, lying in the canal. The meatus looks red and irritable; the ear is quite sensitive to cold, and the patient has mucous and glandular troubles generally.

Nitric acid is sometimes called for, when the general symptoms are much like those of *Calcareo phos.*, and there is impaired digestion, sore mouth, mental depression, and considerable debility.

China, Hepar, Silicea, and other medicines are sometimes needed for peculiar phases of the disease, but their use is sufficiently indicated in other places.

This disease requires local treatment for its cure, and, if the

treatment I have indicated be followed closely, the physician will be gratified with the results.

Phlegmonous Inflammation of the External Auditory Canal.—This disease is exceedingly painful, and lies midway between furuncle and anthrax. Though it may follow closely upon the former, as a deeper extension and sequel of it, as mentioned before, that is not its usual mode of propagation. It arises more frequently *de novo*, by a localized congestion, cell proliferation, infarction, and gangrene of the subcutaneous cellular tissue of the cartilaginous portion of the auditory canal, not extending to the osseous part, and by its symptoms indicates that it is a disease worthy of individual consideration.

It occurs most frequently in persons of bilious temperament, strong muscular development, vascular turgescence, rheumatico-gouty tendency, and dissipated, careless habits. Such constitutions are prone to severe inflammatory affections, and they arise in the ear from slight injury by ear picks, from other inflammations of the canal, from throat affections, parotitis, exposure to draughts, severe cold, and night debauches all about town.

This disease is rarely seen in children and women; the men attacked are generally below par, as to health, if they are not disposed to be irregular and imprudent in their cups.

The trouble begins with fulness and itching in the meatus; shooting pains through the ear and side of the head, and chilly sensations, followed by considerable fever. The whole aural region, particularly, in front of and below the auricle, is red, swollen, throbbing, and painful, and the pain is increased greatly by moving the auricle or the jaw. The canal is soon closed by the swelling, which is generally upon the lower and anterior portion of the canal, and prevents an examination of the membrana tympani. Sometimes neither the smallest speculum nor a small probe can be passed between the walls of the canal.

A sanguineous serum soon begins to come from the meatus, and pus, working towards the wall of the canal, may break into it and flow outwards, bringing relief from the severe symptoms.

This does not happen very early, but the symptoms increase in violence. The pain is sometimes so great in the whole side of the head, that it resembles meningitis; there is deafness, tinnitus,

heavy throbbing, headache, vertigo, photophobia, sleeplessness, restlessness, loss of appetite, thirst, considerable fever, weakness and depression of mind. The covering of the osseous canal, and the membrana tympani is generally hyperæmic, and in some instances becomes decidedly inflamed, with perforation of the membrane, but these changes are recognized with difficulty, owing to the great swelling.

There are but two diseases liable to be mistaken for this—furuncle and anthrax. The first will be limited to one part of the canal, and the region around the auricle will not be swollen much; the other will have more terrific symptoms and great prostration of strength.

If the disease is left to domestic or unskilful practice, after long and useless suffering, a rupture in the canal wall takes place and pus is discharged through the meatus. The pus may, however, work its way through fissures in the anterior portion of the auricular cartilage, and get around the temporo-maxillary articulation, or between the layers of fascia in the parotid region; or it may pass through a fissure in the posterior superior part of the canal and form an abscess upon the mastoid.

Graver accidents than these happen sometimes. Occasionally gangrene, and considerable loss of tissue occur, with disease of the temporal bone, and death from cerebral complications. A more common result of maltreatment, after a spontaneous discharge of pus, is the persistence of sinuses beneath the skin of the canal, a formation of granulations and polypi at their fistulous openings, a continuous discharge of pus from the meatus, persistent swelling, moderate pain, tinnitus, and deafness. In other words, the disease becomes mild and chronic, and unless treated in a proper manner, will trouble the patient a long time, and then leave him partially deaf, if nothing worse supervenes.

Treatment.—From the above description, the reader will perceive that the disease is severe and dangerous, and demands energetic treatment. Relief must be had by the patient soon, to lessen the great suffering and prevent dangerous complications. In the early stages, close the external meatus firmly with cotton, and spray the meatus and surrounding aural region, once every hour, till the parts are blanched, with a mixture of one part of

Aconite tincture and two parts of Sulphuric Ether ; give cold lemonade freely ; forbid warm things generally ; put eight drops of Aconite tincture in half a glass of water, and give a tablespoonful every two hours. It will be remembered that Aconite is a local anæsthetic and antiphlogistic, and so is Ether, and, when applied in this manner, they will diminish the congestion by acting upon the vessels in front of the tragus which supply the canal, and thus retard the inflammation, until the internal doses of Aconite reduce vascular excitement, and, perhaps, cure the disease.

Writers upon diseases of the ear make a great bugaboo about applying cold or poultices to the ear. I thought it strange that inflammation about the ear should require such exceptional treatment, and questioned it at the outset of my career. I have elsewhere stated that poultices judiciously employed are not injurious to the external auditory canal or membrana tympani, and I now assert that cold applications may be used freely about the ear without danger of injuring it. They are not any more liable to injure the ear than a cold gargle. I have used cold douches and washes for the canal and middle ear thousands of times, with no known case of injurious consequences, and have frequently sprayed the external meatus, canal, and, even, the membrane with ice water and ether, before operations, in order to diminish sensibility, and have had no bad consequences beyond a little smarting at the time. I therefore recommend the above cold application as a remedy against phlegmonous inflammation. I have used it in several cases of this disease, and of furuncular inflammation, both in the acute and chronic stages, and have found it of decided benefit.

The patient with phlegmonous inflammation does not apply for treatment soon enough. After the cellular tissue of the affected spot has begun to break down into pus, it is hardly rational to expect to abort the case, but even then the above treatment is frequently useful and may be successful. When there is no longer hope of arresting the phlegmon, and the patient is profoundly shaken up, the canal should be steamed with a mixture of one part of Aconite tincture and eight parts of water, and a

hot hop poultice saturated with laudanum placed over the ear. Keep the cotton in the ear, but wet it occasionally with glycerine.

Belladonna is often indicated at this stage by the local heat, the throbbing, and the cerebral symptoms. It should be given in drop doses of the tincture every hour. I prefer to push the Belladonna strongly, rather than resort to Opium, that masker of symptoms and danger, which seems to have little effect even in large doses in mitigating the sufferings from aural inflammation. When it does so act, in my opinion, it increases the general severity of the lesions. I formerly used Morphia freely in aural inflammations, but neither from my experience then, nor from the reports of its use in special treatises can I find results that would warrant its use to the exclusion of other medicines. When the swelling and severe pain persist in spite of the measures recommended, keep the hot hop poultice applied over the ear and aural region, and alternate Hepar with the other medicine. If the pain continues unbearable, douche the ear frequently with a hot decoction of hops, say a cupful, to which add one tablespoonful of Opium tincture, and reapply the hop poultices hot.

After waiting a reasonable time, say twenty-four or thirty-six hours, if the pain continues severe notwithstanding the treatment, a narrow bistoury should be passed in the meatus half an inch or more, and one, two, or three incisions, according to the severity and extent of the inflammation, made in the wall of the canal through the place of greatest tenderness and swelling. The bleeding should be encouraged by a warm douche, and when it ceases, the poultice be reapplied. These incisions relieve the great tension and congestion of tissues, permit the escape of pus, if any has formed, and reduce the violence of the pain and other symptoms.

In some cases, the pain is not severe, and may be endured, then the poultice and medicines should be continued steadily several days. If neither maturation nor resolution occurs, and the canal and meatus are swollen, boggy, and hard, with, perhaps, one or two of the cervical glands enlarged and a little sore, Mercurius will hasten matters to a crisis. A powder of Mercurius sol. or of Mercurius corros. should be given three or four times a day, and the poultice renewed often.

Whenever pus elevates the skin or can be detected by its fluctuations under palpation, it should be let out by a free incision, and a poultice of flaxseed meal take the place of the hops. As soon as suppuration ceases, stop poulticing, and syringe the ear as often as necessary to keep it clean.

Should fistulous openings remain, they must be injected daily with diluted carbolic acid (*Acid. carbolicum* gr. xx, *Aqua* fʒj) or, if this fails to cure them, a probe coated with nitrate of silver (melted upon it) should be pushed to the bottom of them twice a week. Granulations and polypi sometimes appear around these openings, and must be treated with the silver nitrate, or iron solution, or be removed by instruments.

Caries of the osseous canal rarely results from this disease; its treatment will be found farther on.

In some rheumatic persons, with sore throat on swallowing, and a stopped numb feeling in the ear, the swelling and boggy condition of the canal tends to chronicity, after the active trouble has passed. Kali hydriod., given in water, three times a day, will stir up the morbid tissues in such patients, and promote a cure faster than any other medicine. One case I remember of this sluggish character; after trying Hepar, Kali bichrom., and Mercurius, I gave Kali hydriod. The patient said at the next visit, "that medicine did me good—went all through me, and my ear is better." After a few days, as improvement was not marked, I gave Mercurius. The patient reported next time, that he was not so well. I then returned to the Kali hydriod., gave it steadily, and the ear was well within two weeks, though the man, who was a fireman, was much exposed at night.

In other cases of this character, where there has been hepatic and gastric disorder, as the result of intemperance or high living, Nitric acid and Nux vomica have proved most useful, singly, in improving alimentation and helping to cure the ear.

Arsenicum, Calcareo phos., Cinchona, Ferri murias, and Phosphorus may be indicated rarely, and employed to complete the cure. In all of these cases, the patient should have his diet regulated, his general surroundings scrutinized and sanitized if necessary, and the skin kept in good order by occasional baths. After the convalescence is established, if the patient can get away

a fishing, or go to the seashore for awhile, it will do him a "heap of good."

Osteo-periostitis and Exostosis.—In several of the affections of the canal already described, I have made mention of the superficial inflammation extending along the osseous portion of the canal. It must be recalled, that the skin and periosteum of this region are so thin and firmly united as to be practically one, so that a dermatitis of the one would be periostitis of the other, and *vice versa*. Beyond congestion and some exfoliation of epithelium, this part of the covering of the canal is not profoundly affected in the majority of cases of disease of the canal, as a whole, and of the middle ear. When it does become inflamed either primarily or secondarily, the symptoms are marked. Inflammation of the meatus or outer portion of the canal; injuries by caustics or instruments; irritation from the discharge of pus during suppuration in the tympanum; caries of the temporal bone from scrofula; necrosis from abscess; rheumatism, gout, and syphilis; all are causes of its propagation.

The disease begins with itching, fulness, redness, swelling; dull, heavy, aching pain, worse at night; slight impairment of hearing, and tinnitus. The membrana tympani may be hyperæmic, thickened, perforated, or destroyed, according to the cause of the disease and its complications.

The inflamed periosteum may return to a healthy condition spontaneously, or under treatment; or it may form bone beneath it, when tumors of various shapes arise gradually from the wall of the canal and thus diminish its calibre. They are occasionally seen upon the upper wall, but are most frequent upon the posterior and anterior walls, and may entirely occlude the passage to the drumhead. After they reach a certain size, they prevent the falling out of epithelial débris; retain water at the bottom of the canal after washing or swimming, and thus cause gradual or sudden deafness. In some cases, these tumors single, or multiple, close the auditory canal entirely, and if disease and discharge exist within, they will obstruct the outward flow of pus and cause dangerous, if not fatal, disease of the temporal bone and brain.

The tumors originating in osteo-periostitis are true bone of compact tissue. When an ossific projection, due to localized per-

ioestitis, forms at the seat of a fistula from carious bone, or a group of granulations undergoes organization into bony tissue, as sometimes happens, the tumor is of looser construction than true bone.

The densest tumors found in the external auditory canal, deserving often the name of ivory exostoses, have an entirely different history from those arising from periosteal inflammation. They are seen mostly in the rheumatic and gouty, and may reach a large size without the afflicted one being conscious of their presence. A sudden deafness from closure of the canal by water or cerumen, a consciousness of increasing dulness of hearing, or putting the finger into the canal to relieve irritation, may call attention to something wrong, and examination will reveal the growth. Fre-

FIG. 68.

EXOSTOSIS ON THE POSTERIOR WALL OF THE LEFT EXTERNAL AUDITORY CANAL (Schwartz).
CANAL (Schwartz).

quently, however, in these cases, there is a heavy feeling in the ear and side of the head affected, impaired hearing, and irritation of the canal, with an accumulation of dirt inside the tumor.

The canal should be illuminated by the mirror and speculum, and every part of it scrutinized carefully by the eye and probe. If the bony walls are carious, particles of bone will be found in the discharge; fistulous openings may be discovered near rough osseous growths, and the probe may be passed into sinuses leading to dead bone.

Tumors from diffused periostitis, granulations, rheumatism, gout, and syphilis have broad bases and grow very slowly. It is very difficult to diagnose these, unless they are very prominent, or have reached considerable size. The walls appear irregular, the canal narrowed, and the tumor, in general, red, hard, and tender to the touch of the probe. Pus beneath the lining of the canal projects

like a tumor, but may be diagnosed by its yielding to pressure of the probe, while an osseous tumor will not. When the tumor has become large enough to interfere with the normal action of the canal, it is easily recognized.

The prognosis depends upon the character and size of the growths, the constitution of the patient, and the capabilities of his medical adviser. It is grave when there is caries, or his physician is not thoroughly educated in aural surgery.

Treatment.—Osteo-periostitis is treated in the beginning the same as superficial dermatitis of the canal, upon which it generally depends. Warm water injections, variously medicated, the hot hop poultice, and Aconite, Belladonna, etc., will ameliorate the symptoms. A piece of linen smeared with cold cream is very agreeable to the inflamed surface, during the interval between the douches. If the pain is severe and not relieved by the usual measures, incise the lining down to the bone and continue the douches.

If caries coexists, the parts should be syringed several times daily with warm tar water, sequestra and spicula of bone removed, and fistulæ injected with a solution of carbolic acid, or cauterized by nitrate of silver, as before described. Debilitated patients should drink cream, and have eggs, rare beef, oatmeal mush, corn cakes, and other good things, supplemented by a little ale or porter. A course of sulphur baths will prove very beneficial; the patient's habits must be carefully regulated, and an out of door life insisted upon.

Calcareæ phos. is the best medicine for osteo-periostitis in strumous patients, and has helped to cure many cases of caries in all parts of the body. Calcareæ iod. I have used with decided benefit, and, also, Arsenicum iod., in the same class of cases. Ferrum iod. and Cinchona are indicated, by preference, if there is hydræmia and great debility, and Silicea and Sulphur are useful in the declining stages of the disease.

When rheumatism, gout or syphilis are at work upon the constitution by their specific poisons, the treatment should be decidedly different. Subacute inflammation of the periosteum is allayed by daily application of a ten grain solution of nitrate of silver on brush or cotton. After the soreness diminishes, apply to the

tumor Iodine tincture, or better, rub in daily a little iodine ointment (*Ung. Iodinii Co., Ceratum Simplex*, āā ʒiv). If the soft tissue over the tumor is thickened, an iodide of mercury ointment should be preferred (*Hydrarg. Iod. rub. gr. x, Vaseline ʒj*). If any fluid or dirt is retained in the canal by the exostosis, it ought to be carefully syringed away, and the fluid removed by absorbent cotton.

When the tumor begins to block the canal much, take a short piece of catgut the diameter of the opening, smear it with vaseline, and push it in firmly; this will swell and dilate the canal. Keep on introducing larger pieces every day, until the passage is dilated as much as desired, or as much as possible. A little cotton may be placed over the pieces to hold them in for from four to twenty-four hours, unless severe pain demands their removal. Catgut is much better than laminaria or prepared sponge, because these swell too much and too fast, and thus one is forced to remove them before they have dilated enough. Bougies have been used for this purpose, but they are not to be recommended.

The dilatation does not influence the bony tumor much, but it causes shrinkage, and thinning of the superimposed soft tissues, and thus enlarges the passage to the membrane. A little cold cream may be rubbed over the seat of the tumor after the catgut is removed, and when the soreness disappears, the iodine solution or iodine ointment should be applied to reduce the bony excrescence.

When the tumor reaches a size that threatens to close the meatus, especially, if there is any purulent disease of the membrane or middle ear, it must be removed by a surgical operation. This is done as follows: An incision is made over the exostosis and the covering pushed aside. Then take the hand drill or the dental engine and a proper drill, pierce the tumor through and through in several directions, and finish its removal down to the canal wall with a small chisel, the mastoid curette, and bone forceps. The soft tissues should then be smoothed out over the wound, and covered by a piece of lint smeared with simple cerate (*Ceratum Simplex*).

The wound should be cleansed daily by syringing with warm

water. Should it not heal kindly, or fungous granulations or polypi arise, the part should be brushed with nitrate of silver solution or touched by the solid Lunar caustic.

The internal medication will depend upon the local and constitutional symptoms.

Aside from medicines indicated by the general symptoms, as Bryonia, Colchicum, Nux vomica, Mercurius, Kali hydriod., etc., some cases of eburnation related in *Helmuth's Surgery*, and one case reported by Dr. W. R. Childs, of Pittsburgh, Pa., in the *Transactions of the Hom. Med. Soc. of Pennsylvania*, 1879, would lead me to employ the remedy they used, *i. e.*, Hecla lava. This seems to exercise a unique influence over exostoses of unusual hardness, and merits extended trial.

Kali hydriod. is a medicine that has proved curative in numerous cases of osteo-periostitis, whether idiopathic, or dependent upon some vice of the constitution, and ought to be administered in decided doses, three times a day.

Silicea is a medicine that may prove of value in this disease, as it is thought to exercise a decided influence upon the nutrition of bone, but I have had little experience with it in the affection under consideration, and that not very satisfactory.

CHAPTER V.

INJURIES AND DISEASES OF THE MEMBRANA TYMPANI.

The Membrana Tympani.—The appearance of the tympanic membrane varies with the kind of light employed, the degree of illumination, the age of the person, and the condition of the ear. The short white process of the malleus is generally the first point upon which the eye rests in an examination. The folds of mucous membrane from this are seen upon the inner surface of the normal drum head, one curving to the anterior, and the other to the posterior border, dividing the membrane into a small upper part, like a spherical triangle, called Shrapnell's membrane, and a large lower heart-shaped segment. The handle of the malleus, generally yellowish white, is seen curving from the short process, slightly backward and downward, and at its end is the apex of the silver white triangle, the base of which rests upon the anterior inferior periphery of the membrane. In some persons, the base does not quite reach the border. The manubrium and triangle divide the heart-shaped portion into an anterior and posterior segment.

Around the periphery of the membrane, especially, above and behind, there is a yellowish border $\frac{1}{2}$ mm. wide, which is caused by the different reflections of light from the membrane and canal walls, by the thicker periphery of the membrane, and by the pouches and chorda tympani nerve inside. This zone is 2 mm. broad in old age, of a yellowish pearl color, and is due to degeneration. It is thus an analogue of the *arcus senilis* of the cornea.

The child's tympanic membrane is placed so obliquely, owing to non-development of the temporal bone, that the earlier the age, the greater the difficulty of getting a glimpse of it. Indeed, the first year it is nearly horizontal.

The color of the membrane is light violet, which gradually changes to ashes of roses in the adult, and to bluish and yellow-

ish-gray in old age. The membrane behind the lower half of the malleus handle is sometimes, in adults, yellowish-gray from the light reflected from the surface of the promontory within.

The healthy membrane should show no marbling, dead colors, or striations; it should present to the eye a lively blush by daylight, which is toned off by gray, when artificial light is used for illumination.

Great alterations from the above are seen in cases of ear disease, which will be mentioned in their proper connection. I may say, however, that the short process of the malleus and its folds, and the manubrium become more conspicuous with depression, and the manubrium looks as if it were shortened. The silver triangle may be divided into an apical and a truncated portion; may lose a portion of its base; be in scattered spots, or have disappeared entirely. The colors of the whole membrane undergo many modifications.

When Siegle's speculum is used, and the air is rarefied upon the surface of the membrane, the segments bulge outward, leaving the malleus handle and short process in a furrow. The anterior portion moves a little, the posterior much more, and the manubrium makes a quick pendulum-like movement forward and backward, and inward and outward, as the air is alternately rarefied and condensed.

Thickening of the membrane, partial ankylosis of the ossicles, and adhesions within the tympanum diminish the mobility. The membrane is thickened around the periphery, atrophied and thin in the centre, and the bones are partially ankylosed in old age; so the manubrium moves slowly through a limited space, and the umbo bobs in and out, while the anterior and posterior portions of the drum-head move but little.

The membrane loses its natural funnel shape with depression, and becomes irregularly pouched inward, and, perhaps, attached to the inner tympanic wall by fibrous bands. When a depressed membrane is drawn outward, it becomes immediately depressed when suction ceases, as the shortened tensor tympani muscle and elastic bands drag in the manubrium again. When adhesions of the membrane to the inner wall of the tympanum exist, the adherent portions will remain flat and immovable, and little linear

folds and pouches will rise and fall, as the pneumatic speculum is used. Perforations are detected by this instrument, when the Eustachian tube is not pervious, by the bubbles of air and liquid which come from the middle ear through the opening. Small perforations look like a linear tear, or a black hole, and large ones show the red or granular, inner wall of the tympanum. The granular tympanum can be distinguished from a polypus by the outlines and movement of the latter.

Injuries of the Membrane.—The drum-head is a delicate membrane stretched obliquely across the bottom of the auditory canal, with air upon each side of it, and reminds one of those papered hoops through which equestrians spring, as they ride around the ring of a circus. It is easily injured by changes in the equilibrium of the air upon its two surfaces, and by things thrust in the external canal. The membrane is torn by hairpins, knitting needles, sticks, and ear-spoons pushed in the ear to relieve its itching or to remove wax. It is frequently ruptured by attempts of the laity or incautious physicians, to remove foreign bodies from the external canal; and by blows upon the auricle from any source, such as by the hand, a snow-ball, or a wave upon the sea-shore.

Blowing the nose, sneezing, coughing, violent inflation, vomiting, strangulation by hanging, diving from a high place into the water, a fall upon the head, the discharge of a pistol near the ear, or the report of a heavy gun will sometimes tear the membrane; but in most of these cases, there is disease and weakening of its layers from affections of the external canal or of the middle ear. The membrane is torn by fractures of the temporal bone as before mentioned, and very frequently perforated by disease of the external canal and tympanum.

A person going up in a balloon or upon an inclined plane is conscious of a disagreeable pressure and, sometimes, pain deep in the ear. This is occasioned by a difference in density between the air pressing upon the outer and inner surfaces of the tympanic membrane. It is more marked in persons, who have some disease of the mucous membrane of the Eustachian tube, by which the air cannot readily pass into the middle ear to push the membrane out, and thus oppose increased external pressure; or,

when condensed in the ear, can not escape readily to diminish density within to correspond with rarefaction without.

In coming down one of the Pittsburgh inclined planes, 640 feet long, at an angle of 36° from the horizontal, running by a stationary engine and machinery of winding wheels above with endless wire ropes, one experiences a heavy pressure in each ear as if a large bullet filled the entire middle ear closely, and at the same time there is roaring tinnitus, accompanied by slight giddiness.

The descent forces air into the external canal against the membrane and thus condenses it; but, unless special effort is made, the middle ear does not receive condensed air, and thus equilibrium is destroyed, the membrane is pressed inwards, the middle ear becomes congested, and the symptoms are produced.

This is an example of what occurs with more severity in the so-called caisson disease. In submarine operations, such as building the piers of bridges in deep water, it is necessary for the men to work in caissons, filled by condensed air to resist the inward pressure of water, and to serve for respiration. The deeper the caisson is below the surface, the greater is the pressure of water, and the more must the air within be condensed to resist it. The degree of density may range from twenty to one hundred pounds or more to the square inch, above the fifteen pounds to the square inch of normal atmospheric pressure. When the human body, adapted to the latter pressure, is called upon to endure a pressure much higher or lower, it is not surprising that great disturbances occur in the respiratory and vascular systems. Rarefaction produces surface congestion and epistaxis, as so many have experienced, ascending at railroad speed the eastern slope of the Rocky Mountains. Condensation causes internal congestion and inflammation.

The membrana tympani is kept in equilibrium in condensed air by its free passage through the Eustachian tube to the middle ear. Obstruction in this tube, arising from slight catarrh of the mucous membrane, from its swelling and thickening, or from pharyngeal or middle ear affections is a very common disorder, leading slowly to deafness, and often not suspected by the person afflicted. When the tube is obstructed partially or wholly,

the air cannot get into the middle ear—behind the membrane—readily, and hence the air of the middle ear is less dense than that without. The general vascular pressure is increased by the condensed air acting upon the surface of the body and lungs, and the full turgid vessels of the middle ear, meeting a weak counter-pressure in the relatively rarefied air therein contained, rupture spontaneously and induce an acute inflammation.

When the air of the middle ear is much rarefied, and the external air is very dense, with the membrana tympani somewhat weakened by disease, the great pressure upon the outer surface may cause a rupture and a restoration of equilibrium. The first effect of the condensed air of the caisson upon the ear was to produce a stopped feeling and severe pain. When the Eustachian tubes were opened by the Valsalvian method, the symptoms disappeared. In persons with normal Eustachian tubes, which opened with the act of swallowing, no discomfort was experienced. When a person returned from the dense air of the caisson to the ordinary atmosphere, the condensed air of the ears sometimes came from the Eustachian tubes in distinct puffs.

From numerous cases of disorder of the ear from working in caissons, which came under the observation of experienced aurists, it was concluded that there was generally some pre-existing disease of the Eustachian tube or middle ear.

Inflation by the Valsalvian method was of great use to the men when on duty, and by Politzer's air-bag, during the intervals of labor when they could see the doctor. The pain and hyperæmia of the ears were thus relieved and acute inflammation prevented. Those who wish to pursue this subject farther will find an excellent résumé in Dr. Roosa's excellent treatise upon diseases of the ear.

Whether the *healthy* membrana tympani is ruptured by concussions in the atmosphere from discharge of fire-arms and artillery, is a question still *sub judice*. The resisting power of a healthy membrane is considerable. Gruber found it required a column of mercury 143 cm. (56 in.) high to rupture the membrane of an ear, that had been preserved in alcohol several weeks. He was unable to burst a healthy drum-head by five times the atmos-

pheric pressure, sent through a catheter fastened in the Eustachian tube.

The triangular space above the short process of the malleus, called the *membrana flaccida*, or Shrapnell's membrane, is elastic and less dense than the other parts of the membrane, and yields considerably to pressure. The funnel-shaped part of the membrane is made concave by pressure from without, so that the triangle of light disappears, and this indicates an elasticity of conservative character in sudden movements of the atmosphere. The oblique position of the membrane, the projecting angle of cartilage at the junction of the osseous with the cartilaginous portion of the external canal, and the easy patulence of the Eustachian tube, all contribute to protect the *membrana tympani* from violent aerial commotions.

Nevertheless, it is sometimes ruptured by explosions of gunpowder, in pistol, blast, or cannon. Yet, the scarcity of cases among soldiers and sailors, who have been exposed to "heavy firing all around," renders it probable, that those who have suffered this accident have had some chronic disease of the ear, which has weakened the layers of the drum-head, and predisposed it to rupture. Cases are on record in which rents have resulted from pistol-shots near the ear, the explosion of a hand grenade, and the discharge of heavy guns.

The symptoms of concussion without rupture are, a heavy thud in the ear, a temporary intense ringing, some degree of deafness, and sometimes slight hemorrhage of the membrane. When a rupture occurs, a sharp pain shoots through the ear after the thud, a discharge of blood appears in the external meatus or within the canal, the deafness is more decided, and air flutters out freely, when the ear is inflated through the Eustachian tube.

During a service of five years, including the period of the late war for the Union, as a line officer in the United States Navy, exposed with many others to a great many concussions from the discharge of guns, ranging from 12 pound howitzers to the 200 pound rifled Parrots, and the 11 inch and 15 inch smooth bore guns, I did not hear or know of a single case of such aural injury.

At the battle of Bull's Bay, S. C., on board the U. S. Gun-

boat Ottawa, a 200 pound rifled Parrot, taking a charge of 20 pounds of powder, and a shell of 155 pounds or a solid shot of 200 pounds, was fired four or five times an hour for thirty-six hours. During most of this time, being Executive Officer of the ship, I remained upon the bridge within fifteen feet of the gun, directing its service, and the same men, with one or two exceptions, remained at their posts close beside and behind the gun carriage, yet, no ears were injured to the best of my knowledge, and that of Dr. L. H. Willard, who was Surgeon of the ship.

In the iron-clad service, the trial of auditory resistance was even more severe. The guns within the revolving turrets were of XI inch, and XV inch bore, requiring charges of 15 to 20 pounds, and 35 to 40 pounds of powder, and shell of 136 pounds, and 350 pounds, or solid shot of 166 pounds, and 400 to 440 pounds respectively. When fired, the muzzles of the guns were run just even with narrow port-holes through the eleven-inch thick turret, and, though the concussion was greatest outside, yet, owing to the confined space of the turret it was considerable within. This had to be endured for whole days at a time, together with the shocks from shell and shot striking the outside of the turret, during the frequent attacks upon Moultrie, Sumter, and the Confederate forts upon Morris Island.

I was an Ensign then on board the U. S. Ironclad Nahant, and had charge of the XI inch gun, while Lieut. Tallman commanded the XV inch. We were all instructed to keep the mouth open at the moment of firing, but we sometimes forgot the warning, and our ears would ring loud and deep after a discharge. I noticed after a few hours firing, the ringing would persist, perhaps, till the next bombardment.

In the excitement of action, we sometimes did not get the muzzles of the guns quite against the edge of the port-hole, and upon firing, we would get a shock inside the turret, that would make our heads swim. On one occasion the XV inch was hurriedly discharged, when the muzzle was several inches inside the port-hole, and every one of us was stunned and knocked over by the powerful concussion, but no one complained of the symptoms of a ruptured membrana tympani, though some had ringing tinnitus and vertigo for several days. Rupture of the membrana

tympani is therefore not easily caused by artillery concussions. My experience agrees with Gruber's. He saw a great many patients, who had been in heavy battles, and found only one case of rupture of the drum-head.

I have recently examined an ear injured by cannon firing. Lieut. Stephenson was superintending the service of the "Swamp Angel" in a marsh before Charleston, S. C., and at one discharge he felt a thud in his right ear and a quick sharp pain, followed by a discharge of blood from the meatus. The ear did not trouble him afterwards, but hearing was much impaired, and has remained defective since. No trace of a cicatrix remains, but the membrane is opaque, depressed and adherent to the inner wall of the tympanum, and Hw. is $\frac{5}{8}$.

Observation leads me to believe that the intermitting concussions of artillery do not cause chronic inflammation of the middle

FIG. 69.

FIG. 70.

FIG. 69.—RUPTURE OF THE MEMBRANA TYMPANI (Schwartz).

FIG. 70.—ROUND PERFORATION OF THE MEMBRANA TYMPANI WITH CALCIFIED EDGES, TWO CALCAREOUS SPOTS, AND LARGE CICATRIX (Schwartz).

and internal ears, as Roosa claims, though the clatter of noisy machinery and the clang of the boiler-maker's hammer may do so.

Solutions of continuity of the membrana tympani have various shapes, and occur in different locations, which are dependent upon the cause. They are seen a little distance from the anterior or posterior surface of the manubrium, or along the periphery; are round, oval, or irregular shaped perforations; in the anterior, posterior, or superior segments. Those resulting from injury by foreign bodies, by concussions and recent acute catarrhal inflammation, are linear rents with thin ragged edges. Those produced by disease are generally round, oval, or kidney shaped, and have thin or thick, inflamed and sometimes calcified borders.

There may be several perforations. Small round perforations, one upon each side of the manubrium, resemble the eyes of an embryo chicken. Perforations may be so small as only to be discovered by the passage of air through the membrane during inflation, or so large that hardly a vestige of the membrane remains. Frequently the tendinous ring around the periphery and the part immediately surrounding the malleus are all that remain of the membrane.

FIG. 71.

KIDNEY-SHAPED PERFORATION OF THE MEMBRANA TYMPANI WITH
CALCIFIED EDGES (Schwartz).

In these conditions, the handle of the malleus is drawn in by the tensor tympani muscle, adherent to the promontory of the tympanic wall, and so foreshortened as to be seen with difficulty. In other cases, the ossicles have been broken, dislocated, and partially or wholly discharged, and the edges of the perforation or its cicatrix have become adherent more or less with the mucous membrane of the tympanum.

Schwartz says, 'The perforation takes place from within outwards, during purulent otitis media, and from without inwards by perforating ulcer, or as the result of an abscess of the membrane during myringitis. Various conditions unite to produce these perforations; inflammatory softening of the membrane, pressure of exudation behind it, and movement caused by expiration. A rupture occurs, the edges of this ulcerate (if it does not heal), and a loss of substance follows. The extent of loss of substance depends on constitutional conditions, and is most rapid and destructive in scrofula, tuberculosis, and especially in scarlet fever.'*

* The Pathological Anatomy of the Ear, p. 78.

A rupture may heal and leave no trace, or have a linear or broad cicatrix. Very large perforations sometimes close after many years existence. In certain cases of tubal and middle ear disease, a perforation materially improves the hearing by permitting sound vibrations to strike directly upon the oval and round windows of the labyrinth. The size, shape and position of perforations influence the degree of audition, but no definite rules for guidance are yet formulated. It may be stated in general, that small perforations are accompanied by poorer hearing than large ones.

Treatment.—Simple rents of the membrane heal readily and leave no scar. When there is no pain and deafness after an accident from a foreign body or from concussion, inflate the tympanum through the Eustachian tube with the air-bag, in order to drive out any blood there may be therein; syringe the ear gently with tepid water, put in a loose wad of cotton, give a few doses of Aconite and keep the patient quiet. The membrane will probably heal in such cases, and leave no trace of the injury. Should the perforation be large, and coexisting with any of the diseases of the canal, membrane or middle ear so commonly accompanying, these must be treated first, and the measures adopted for their cure will be favorable to the closure of the membrane. The membrana tympani possesses great regenerative power, and more than two-thirds of it, including the malleus, may be destroyed and completely restored, even, after a perforation has existed many months.

The membrana propria of the drum-head is not restored during reparation, but a leash of bloodvessels runs to the edge of the opening, deposits pabulum, and a firm whitish cicatrix marks the place of lesion. This is depressed below the plane of the membrane, but is usually covered by epithelium upon both surfaces. Cicatrices look darker than the surrounding membrane, are more movable, and may be adherent to the long process of the incus, or to the inner wall of the middle ear, directly, or by the intervention of bands of connective tissue.

It is better to keep the meatus closed with absorbent cotton, during the intervals of treatment, but a discharging ear should not be thus plugged unless the physician can see the patient often,

or the latter can be relied upon to cleanse the ear, and change the cotton often. When a membrane is healing, no inflations should be employed unless imperatively demanded, as forming cicatrices tear easily and closure is thus arrested. It is advisable to avoid syringing, to cleanse the canal with absorbent cotton, and to avoid removing scabs and scales from the perforation, as the latter bridge the gap and favor cicatrization.

With nothing to interfere with healing except sluggish action of the membrane, cover a silver probe with solid nitrate of silver and rub it around the edge of the perforation. In such cases, the outer and inner coverings of the drum-head have united, and the opening will remain permanent, unless cauterized and stimulated to close.

A perforated membrane may become entire by the formation of a cicatrix, but have the latter covered by pus, owing to the imperfect epithelium upon its surface. These places should be cleaned by absorbent cotton and brushed every day with a five-grain solution of nitrate of silver (*Argent. nit. gr. v, Aqua dest. f3j*), and a two-grain solution of sugar of lead (*Plumbi acetat. gr. ij, Aqua dest. f3j*), syringed in the ear daily, while *Calcareo phos.* is given internally.

Dr. J. H. Buffum, of Chicago, Ills., reports the closure of perforations under pledgets of cotton smeared with cosmoline and kept firmly against the surface of the drum-head for several weeks at a time. I used absorbent cotton alone in one case, after touching the edge of the perforation with nitrate of silver, and found the opening closed at the end of two weeks. It was about the diameter of a knitting-needle when first seen.

It has been recently recommended to apply disks of paper and pieces of adhesive plaster to perforated membranes, to protect the middle ear from irritation, and to favor the healing process. They have not worked well in practice so far, and may be regarded as the offspring of exuberant theorizing.

Hyperæmia of the Membrane.—A *membrana tympani* in a normal condition does not show any permanent injection of vessels. When the external canal or the membrane is touched roughly, the ear is inflated artificially or by the inhalation of a strong breeze, the head is subjected to concussion, the Eustachian

tube is irritated by tobacco or slightly obstructed ; the stomach is disordered, or certain medicines are administered, such as quinine ; hyperæmia of the drum-head and of contiguous parts results, and certain subjective symptoms appear. These are so trifling as hardly to attract attention, but some persons ask the doctor about them, generally, from mere curiosity. It is for this very reason that I deem them worthy of notice. A person has a sudden very slight ringing in the ear, which lasts a few minutes, and then ceases, to return again after a few hours or days. The ear feels a little full, and the external canal itches ; it is slightly feverish and hyperæsthetic, so that wind blowing into the ear feels uncomfortable.

If the membrane be examined, one may see a bright red streak of vessels, extending upon the drum membrane above the short process of the malleus from the external canal and running down along the manubrium. Other vessels are sometimes seen running around the drum-head and inwards to join those of the malleus. The mucous layer may participate and give a deeper violet hue to parts of the drum-head. The hyperæmia of the outer layer may be so great as to make the membrane of a diffused red, and to hide the malleus completely from sight, but this condition comes more appropriately under myringitis, into which any hyperæmia may easily develop.

Treatment.—Remove the cause if still operative. Use the air-bag once a day for a few times ; brush the external canal with glycerine and water, equal parts, once a day if needed ; gargle the throat every night with a teaspoonful of salt in a glass of water, if it is irritated ; and give a few doses of Aconite, Belladonna, or China, making the dose correspond with the insignificance of the disorder, and speedy cure will probably result.

Myringitis.—This is a name applied to an inflammation limited to the membrana tympani. It is rarely seen uncomplicated by disease in other parts of the ear, and is difficult to diagnose, because of the relations of the drum-head to the external canal and the tympanum.

The external surface of the membrane is skin, the internal mucous membrane, and a layer of connective tissue lies between. This membrana propria has little vascular or nervous supply,

and hence inflammation of the membrane is generally an affection of the skin, or of the mucous membrane, or of both together. Inflammation of the dermic layer is very common, and has been mentioned as a complication of several diseases already described. A disease of the canal may be very slight, yet, produce such localized inflammation in the drum-head, as to merit its record under the title of myringitis. Disease of the middle ear will cause inflammation of the mucous membrane covering the drum-head, but will probably extend beyond its borders and, hence, not merit this special designation. When the mucous membrane of the drum-head becomes affected secondarily through inflammation of the dermic layer, it is possible and probable, that the disease may not extend to other parts of the middle ear; indeed, I think I have seen several cases of this last variety.

The symptoms of myringitis alone are not very marked; they follow exposure to cold air and drafts, injury by foreign bodies, and diseases of the external canal. There is a slight pain or none at all; the hearing is a little impaired, and noises of varying character rather amuse than annoy the patient. There is no constitutional disturbance, and many cases are not seen by the physician until they have passed into the chronic stage.

When examined, the membrana tympani is found not depressed, but projected a little outwards; it is pink, moist, and œdematous from swelling; or, having exfoliated its epithelium, is uniformly red, owing to the exposure of the corium; the light triangle has disappeared, the handle of the malleus is indistinct, and its position is only recognized by a few bloodvessels running in its course. The membrane is soft, relaxed, and easily torn. The inner end of the canal is sometimes swollen, so that the membrane looks diminished in size. Inflation of the middle ear is generally easy by any method, and the membrane moves, though it may be sluggishly. The disease may not go beyond this condition and recovery follow. If it continues, later in its course, the membrane becomes thickened, leathery, dirty gray and rough, and secretes a little thin pus, the detritus of imperfect epithelial formation. This leads to erosion, an infiltration of round cells, and the formation of granulations and polypi upon the outer surface; blisters may develop and break outwards, abscesses arise in the

connective tissue and burst, fatty and calcareous deposits occur in the substantia propria, ulceration extend deeper and deeper, and perforation finally result. In other cases, the membrana tympani may remain thick and fleshy, the inflammation extend deeper

FIG. 72.

INTERLAMELLAR ABSCESS OF THE MEMBRANA TYMPANI (Schwartz).

and deeper to the mucous membrane of the tympanum, which becomes catarrhal and seriously damages the hearing.

Treatment.—If the attack is secondary to any other aural disease, treat the latter according to directions elsewhere. When myringitis is the predominant affection, syringe the ear gently every few hours, during the acute stage, with a warm decoction of hops, and give Aconite or Belladonna. Inflate the ear with the air-bag, and keep the patient warm and quiet.

After the acute symptoms are past, if the membrane is thick, rough, and diffusely reddened, brush over the surface with the cottoned probe, wet with a ten-grain solution of nitrate of silver. Should there be ulceration and pus upon the membrane, wash it off by an injection of tepid water, and drop in once a day a little of the acetate of lead solution (*Plumbi acetat* gr. ij, *Aqua dest.* ℥j). Blisters and abscesses may be opened carefully with a cataract needle or the myringotome, and afterwards do well with the plumbic wash. In obstinate cases, it may be necessary to apply the mercury and vaseline ointment (*Hydrarg. oxid. rub.* gr. v, *Vaseline* ℥ss.) to the surface by the cottoned probe, or smear a piece of cotton and push it against the membrane, which has lost much of its sensibility. In case of middle ear complication, it might be necessary to puncture the drum-head, but this will be considered under diseases of the tympanum.

Aconite should be administered early to bilious, plethoric, rheumatic or gouty persons. Arsenicum should be substituted as soon as the active symptoms have disappeared, when the membrane is scaly.

Calcareo phos. has proved of much value in a pale flabby state of the membrane, with some discharge, and sometimes blisters or ulcers. Hepar will be appropriate in similar cases, with sensation of coldness.

Silicea helps cicatrization and the formation of new epithelium.

Atrophy of the Membrane.—This consists essentially of an absorption of much of the membrana propria, or connective tissue, between the outer and inner layer of the membrana tympani, with some thinning of the latter.

It is caused by pressure of cerumen upon the drum-head; a prolonged course of inflation of the tympanum; long-continued rarefaction of the air of the tympanum, and the inward pressure of the membrane, owing to continuous occlusion of the Eustachian tube; and by chronic inflammation of the mucous membrane of the middle ear.

The membrana tympani is considerably altered in color. It is yellowish white, yellowish gray, or like dirty chamois skin; has a pearl-colored ring around the periphery, and a centre of bluish white, striated slightly with gray. There may be spots of calcareous degeneration surrounded by a border of dark pigment. The membrane is very thin in the centre, and may be seen to move through considerable space, when Siegle's speculum is used. The greatest movement is around the umbo; the malleus handle moves forward during suction and backward during compression, with a pendulum-like movement. The membrane just behind the manubrium pouches outwards, and laps a little over its border, and other portions show different shaped folds when moved outwards.

If the air of the tympanum is rarefied, or pressure is made strongly by the Siegle, the tympanic membrane sinks into the tympanum, and shows by its irregular surface the position of the ossicles and promontory. When the membrane is quite thin and papery, some of the intra-tympanic apparatus may be seen through

it. This collapse inwards is the usual position of an atrophic membrane, unless the person has learned to inflate his ears and does so frequently; then its depression is considerably less. When the tympanum is inflated there is a soft thud of sound, considerable crackling, and, perhaps, a few moist râles.

Tinnitus of varying intensity is a frequent symptom of atrophy, and, of course, the hearing is considerably impaired. In my opinion the relaxed membranes, thought to be produced by too much inflating of the middle ear, are generally cases of atrophy of the substantia propria from morbid processes of long continuance within the tympanum.

Treatment.—There is not much to be done for an advanced case. Any causative or coexistent aural affection should be treated according to directions elsewhere. If the Eustachian tube is closed and the tympanum is catarrhal, inflate with the air-bag every day, until the tubes are free and open easily. Collodion may be applied over the outer surface of the drum-head with a brush, or the head inclined and a drop or two allowed to dry upon the surface. This may remain a week or two, and will improve the hearing temporarily. An artificial drumhead of cotton or rubber, pressed against the membrane, frequently increases the hearing, and does no harm if not left in too long at a time. When the relaxation is considerable, the hearing very defective, and the tympanum nearly normal as in senile atrophy, I make a horizontal puncture about 2 mm. wide in the anterior and posterior portions of the membrane, upon a level with the end of the manubrium, and 2 mm. in front and behind it. These soon heal and the consequent cicatricial contraction improves the tension and functional action of the membrane. After incising the membrane, if blood flows, it must be syringed gently away, a piece of cotton placed loosely in the meatus, and Aconite given for a day or two. I have performed this operation several times, have not had any bad results from it, and improvement in hearing and diminution of tinnitus have followed in the majority of cases. I have been careful to have the Eustachian tubes easily dilatable, and the tympanum in pretty good condition before operating, and from my results, I feel warranted in recommending the procedure to the attention of the profession.

Hypertrophy of the Membrane.—Long-continued irritation or inflammation of the skin produces thickening of the epidermis and hypertrophy of the corium and subcutaneous connective tissue. The epidermic cells become thickened and their number in a given area greatly increased, while they are closely aggregated into callus and ichthyotic-like patches upon the thickened layer of connective tissue.

The same causes act similarly upon the mucous membrane, but the result is a little different; the submucous tissue becomes hypertrophied, the muciparous glands are enlarged, the surface gets rough and granular, and the superabundance of mucous cells is thrown off as mucus or pus.

The membrana tympani is composed of skin and mucous membrane back to back, with a common subcutaneo-submucous connective tissue, the membrana propria between, and it is conceivable that it may become hypertrophied as well as atrophied.

This is exactly what occurs in some cases of disease of the external canal, often in myringitis proper, and as a concomitant if not a sequel of tympanic disease, though many authors ignore it altogether. It is what Toynbee meant by rigidity of the membrana tympani, and is seen quite frequently in the old, the rheumatic, and gouty.

The membrane is generally dull, opaque, dirty white or yellow-gray, sometimes looking like soiled chamois skin; the light spot is somewhat altered in shape or entirely absent, the concavity is increased, and the handle of the malleus swung a little inwards and, perhaps, invisible, though the short process is usually very prominent.

Whitish patches and lines are sometimes seen, where adhesions with the ossicles or promontory have occurred, and other spots from deposits of fat and lime, are scattered over the membrane, or aggregated in various sharply outlined patches. Deposits of carbonate of lime are very common. They are white, speckled with brown, as if dark sand had been shaken upon white paper, and form linear, oval, round or crescentic plaques between the malleus handle and the border of the membrane.

Fatty granules are often mingled with the calcific particles and give them a yellowish hue. The lime is confined to the mem-

brana propria, or involves all the layers of the membrane. These degenerations may be numerous, yet, the membrane act well, and the hearing not be much affected.

In hypertrophy of the membrane, the hearing is generally impaired, so that the watch is heard only on contact or one or two inches away, and tinnitus is occasionally present, as a dull rumbling or roaring.

When Siegle's speculum is used, the membrane will be seen to move slowly, and the incursions of the manubrium to be much limited. Inflation by the catheter and air-bag gives through the diagnostic tube a dull coarse crackling or low flapping, instead of the sharper sounds of the normal condition.

The patient hears a bass voice best, and hearing is better in a noise, as in a carriage or among moving machinery. Low tones

FIG. 73.

CALCIFICATION OF THE MEMBRANA TYMPANI (Schwartz).

have longer vibrations and thus give the slow membrane time to act, and noises make the membrane more movable by commotion of the ossicles. The patient is obliged to pay close attention to one speaking, in order to understand, and this vigilance is quite fatiguing. There is generally ankylosis of the ossicles and other lesions within the tympanum, which will be considered under proliferative inflammation, or sclerosis of the tympanic mucous membrane.

Acute disease of the ear may originate or complicate a hypertrophy of the membrana tympani; the latter is most frequent.

There are few symptoms to attract the patient's attention. There may be some mucus in the throat, roughness and dryness in the posterior pharynx, a little fulness and tinnitus now and then, and a gradual diminution of the hearing. When the aurist

is consulted, the array of objective symptoms detailed above is found, and the true condition apprehended.

Treatment.—Any disease of the external canal or tympanum, suspected of causing the hypertrophy, must be treated according to directions elsewhere. For a case pure and simple or, perhaps, dependent upon obscure disease of the tympanum, inflate with the air-bag till the tubes open easily by Valsalva's method, brush over the drum-head every third day with a five-grain solution of nitrate of silver, and give Mercurius corros., two grains three times a day.

If the hearing does not improve in a few weeks, brush a spot the size of a penny upon the mastoid, a little above and behind the meatus, with pure carbolic acid, surrounding the part with a ring of olive oil, so that the acid will not whiten more skin than intended. Renew these applications once a week, and continue the Mercurius steadily. Should gouty or rheumatic symptoms become prominent, or any complications arise, give the indicated medicine, but the Mercurius ought to be tried faithfully. I claim no originality for this treatment; it was practiced by the immortal Toynbee, before I was born, but I have proved it to be very useful in several cases. I have found Kali hydriod. of excellent service, where the affection was associated with a catarrhal tendency, and have cured a few cases with granular throats by courses of Arsenicum alb. and Arsenicum iod.

If the deafness is very great or tinnitus distressing after other things fail, make an incision in the drum-head with the myringotome, 2 mm. long, and 2 mm. behind the malleus handle near its lower end. Pain may be subdued by the warm douche and the administration of Aconite. If improvement follows, maintain an opening as long as possible, while a solution of potassium (*Potassii hydras.* gr. j, *Aqua* f℥j) or bicarbonate of sodium (*Sodii bicarb.* gr. v, *Aqua* f℥j) is injected daily into the canal and tympanum, and the proper internal medication is continued. Thus inspissated mucus, pus, and blood can be dissolved out of the tympanum, and adhesions, perhaps, loosened. Suppuration of the middle ear is not likely to occur from perforation properly performed. If the incision tends to close, a Politzer

eyelet may be inserted, or one may dissect out a triangular piece of the posterior inferior quadrant.

Projections of the Membrane.—Under hypertrophy and some other diseases of the drum-head, I have described depressions of various degrees and kinds, and now briefly mention opposite conditions.

Myringitis shows puffiness of the epidermis and a slight projection of the membrane, in front and behind the handle of the malleus.

Granulations spring from the papillary connective tissue of the dermis and form nodules and polypi, which cause irregular elevations upon the outer surface. Abscess, hemorrhage, and tumors between the layers of the drum-head generally work outwards and raise the epidermis.

Acute inflammation of the middle ear causes a red, moist, shining bulging of the membrane, and the malleus appears depressed, or at the bottom of a sulcus between the anterior and posterior projections.

Exudation, hemorrhage or tumors in the tympanum may cause a pushing outwards of any segment of the membrane, but the posterior superior quadrant is most frequently the seat of election.

Hemorrhages in the Membrane.—Small ecchymoses, superficial exudations, and infiltrations of blood occur in the membrana tympani from various causes. The mucous membrane of the tympanum is hyperæmic, during measles, small-pox, typhoid fever, diphtheria, angina and other diseases, and is predisposed to hemorrhage from slight accidents. Hemorrhages appear as round or oval, bluish-red elevations upon the inner surface, and, when seen through the canal and outer layers of the membrane, they have a brownish color and are illy defined.

Ecchymoses and hemorrhages just beneath the epidermis of the drum-head are deep red and generally round. I have seen them at the periphery and at the borders of perforations.

A patient of mine, about sixty years old, had dry external canal; dry, whitish, opaque, slightly depressed drum-heads; annoying tinnitus, and sclerosis of the mucous membrane of the middle ear. After an unusually strong inflation with the air-bag, I perceived at the margin of the superior posterior quadrant

a round extravasation of blood beneath the skin. This elevated the epidermis and in two days time formed a dependent pouch, which I perforated with a cataract needle, and from which flowed several drops of rather watery blood. The membrane healed kindly and no other accident happened.

Ecchymoses beneath the epidermis generally lose their water, form shrivelled clots, which finally undergo fatty degeneration and are absorbed. During these changes, they move slowly to the edge of the membrane, and then outwards along the wall of the canal. This migration is thought to depend upon the growth of the epidermis from the centre of the membrane outwards, though Zaufal believes it is a result of capillary action.

Treatment.—The presence of blood in the membrane may be a symptom of rough treatment which should be stopped, or of grave constitutional disease against which our therapeutic art should be directed.

When the blood remains fluid and points or bulges into the canal, it should be helped out by a puncture. When hemorrhage occurs without any distinctive symptoms of a morbid condition of the ear, and seems connected with Purpura, Ferrum or Secale should be administered until absorption takes place.

Arsenicum and Phosphorus are useful in morbid states of the vascular tissue.

Epithelioma, cholesteatoma, and tubercle are very rare affections of the membrana tympani, and exceedingly difficult to diagnose; therefore I merely mention them here. Any one desiring further information in regard to them may consult Schwartz's *Pathological Anatomy of the Ear*.

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CHAPTER VI.

DISEASES OF THE MIDDLE EAR.

Otalgia.—Earache is one of the commonest symptoms met with in practice, especially amongst children, and the demands for relief are generally noisy and imperative. The term is restricted by some authors to a simple neuralgia of the ear, idiopathic or reflex, unaccompanied by the usual symptoms of aural mischief.

I prefer to use it for all sudden accessions of pain in the ear, whenever it is impossible to obtain reliable data for an accurate diagnosis. Otalgia may then signify a reflex pain from a carious tooth, or the violent lateral headache of beginning inflammation in the tympanum.

Pains in the auditory region vary in quality and quantity, as elsewhere, according to the part affected, and a little knowledge upon the subject will assist in forming a prognosis, and enable one to use therapeutic measures to the best advantage.

Simple neuralgia of the ear is characterized by pain of sudden onset, rapid increase in severity, and sudden cessation. It is irregular and capricious, and darts through the ear with lightning rapidity. There may be slight deafness and a little tinnitus, but the canal and membrana tympani are of normal color, and the Eustachian tube and middle ear are clear to inflation and free from exudation.

The affection coexists with neuralgia of the trifacial, and occurs very frequently from a carious tooth. I had a case of this kind recently. The tooth was badly filled, and a cavity existed beneath the amalgam. The pain was paroxysmal and most excruciating. It extended from the tooth to the ear, and down the neck along the cervical nerves to the middle of the clavicle.

During the paroxysms, there was fulness and throbbing in the ear with slight ringing tinnitus. The tooth was treated by a competent dentist, the pain ceased, and the ear was found in a normal condition.

The early stages of acute inflammation of the middle ear have severe pain like neuralgia, but it is continuous, increases in severity, and spreads over the side of the head. The throat is often affected and the pains shoot along the Eustachian tube through the ear when swallowing. There is generally a history of exposure; some slight pain for a day or two before the severe pain begins; the membrana tympani shows hyperæmia; rales are heard through the diagnostic tube, and inflation brings transient or permanent relief.

Inflammation in the cartilaginous portion of the auditory canal is characterized by dull throbbing, and continuous pain, worse at night. Moving the auricle is exceedingly painful, and some swelling can be detected. Inflammation of the osseous portion of the canal is manifested by a heavy, aching, boring pain in the canal; redness of its walls, and increase of suffering by pressure in front of the tragus. Disease of the mastoid is attended by heavy, aching, tensive pain in the mastoid process and deep within the ear; there is redness and swelling over the mastoid, and the constitutional disturbance is considerable.

Chronic inflammation of the middle ear without a perforate drum-head is accompanied by a heavy, numb feeling in the ear, and a dull, not constant, pain. Sometimes the hearing is temporarily exalted during the pain, which shows spasmodic action of the otic muscles, or a hyperæsthesia of the auditory nerve.

Disease of the internal ear is not accompanied by pain, at least, there is no authoritative record of its presence in uncomplicated cases.

Treatment.—What shall one do for earache? “Drop in sweet oil and laudanum,” says a well-meaning housewife; “put a bag of hot salt over the ear,” says another; “apply a hot roasted onion right on the ear,” says a third. All good and useful sometimes—all failing very frequently, because not governed by prin-

ciple. These are empirical remedies; the new therapeutics of special knowledge and more exact symptom study has something better to offer.

Remove the cause, if still operative, inflate the ear through the Eustachian tube immediately, and renew this occasionally. Swollen gums in infants should be lanced, and sore carious teeth pulled out at all ages. If the membrana tympani is not perforated, syringe the ear gently ten minutes every half hour with a dram of Aconite tincture in a cupful of hot water, and give Aconite internally. If the membrane is perforated, use hop tea alone for the douching. If the pain is not soon relieved, apply a hot hop poultice over the ear, in the intervals of douching. These measures failing, continue the syringing and poulticing, and review the characteristics of medicines for ear disease.

Pulsatilla is indicated when the pains are severe and intermitting, and there is catarrh of the naso-pharyngeal space, with a history of exposure to cold. Arsenicum is serviceable when the patient is subject to neuralgia about the face, the pains are paroxysmal and exceeding violent; and, during the intervals, there is considerable exhaustion. Belladonna is excellent when there are sharp stitching pains through the ears, a loud tinnitus, and considerable cerebral congestion. Bryonia should be given if the pain is moderate, the throat is sore, and there is muscular stiffness and soreness.

Cinchona is called for in fulness of the ear from congestion, ringing tinnitus, and moderate pain; especially, if the patient lives in a malarial region.

Kali hydriod. relieves throbbing, aching, continuous pain and redness in the external meatus. Mercurius corros. is the best medicine for heavy, aching, tensive pains in the mastoid and ear. Lycopodium is recommended for pains of moderate degree and fitful character, and Chamomilla relieves mild earache in peevish and restless children.

The otalgia sometimes continues violent in spite of all treatment, and solutions of morphia and atropia are recommended by some aurists to be dropped in the ear. One grain of Sulphate of Morphia, or Sulphate of Atropia may be dissolved in a tea-

spoonful of hot water, and then three or four drops instilled into the canal, with the head inclined to the opposite side. These solutions are *dangerous* and should not be used by any but a specialist, *who is certain of the soundness of the drum-head*.

It is necessary to add a little Morphia to the therapeutics in rare instances, to benumb the pain, and give the patient needed rest. An eighth of a grain for an adult, every hour till relief is afforded, may be given with safety. I avoid using it as long as possible. Morphia benumbs pain, but it augments cerebral congestion, and thus tends to increase any tendency there may be to inflammation of the ear. It is much inferior to Aconite, which is a local anæsthetic, and an internal antiphlogistic. I treated formerly many severe earaches by the palliative hot douche and Morphia, but in late years have used the Aconite douche for the ear, and Aconite internally, and the evidence in favor of the latter method is overwhelming.

It must be remembered that earache is generally a premonitory symptom of aural mischief, and as soon as symptoms become definite, so that a true diagnosis can be made, the treatment must be sought under the proper nosological name.

Tinnitus.—This is a term employed indiscriminately for all subjective sounds, which originate from internal morbid changes, and not from external aerial vibrations, as is the case in normal audition. These sounds vary from a barely perceptible ringing, heard only when everything is quiet, to a loud, coarse, tumultuous rumbling, that annoys by day and is very distressing by night.

When a sudden shock as the report of a gun affects the healthy ear, there is a musical ringing, clear and pure, as if a glass had been struck. This is the healthy reaction of the nerve, and is generally the sound that inaugurates morbid tinnitus, though it is so trifling that it is often disregarded, till louder whiffing and singing awaken anxiety for the hearing. Hissing as of escaping steam, cooing, soft gurgling, metallic ringing, chirping as of crickets, connected musical notes, and other high tones, interchanging, intermittent, or constant, occur frequently. Less frequent are sounds like the grating of the locust, the buzzing of the beetle, a dull pounding, and the roaring of shells.

The intensity of the sounds is as variable as their quality and pitch, and it is impossible in many cases to connect them with any special morbid condition, or to derive from their consideration alone anything of much value in a therapeutic point of view.

A single sound sometimes continues without variation a long time, while in other cases there is a succession of several sounds, forming quite a gamut. It may be stated as a general rule, that delicate sounds indicate some affection of the auditory organ or the brain, and coarse ones, affections of the bloodvessels contiguous to the ear.

Patients compare the sounds to those with which they are most familiar. They describe them, as ringing, singing, humming, hissing, chirping, buzzing, pounding, grating, rumbling, and roaring. The farmer speaks of the noises of insects and falling water ; the dweller in the city, of steam, machinery, and carriages ; the sailor, of creaking spars, the winds, and the ocean ; and musicians even indicate the notes of the musical scale.

Tinnitus is caused by hyperæmia, anæmia, or disease of the labyrinth, by which the normal pressure of the endo- and perilymph is altered, and the terminations of the auditory nerve are disturbed. It is occasioned by functional or organic changes in the trunk of the auditory nerve, the ganglia with which it is connected, or in contiguous portions of the brain. It may consist of the normal reception of vibrations, which occur from movements of the tensor tympani, stapedius, pharyngeal, or palatine muscles, of exudations in the Eustachian tube or middle ear, and of blood currents in neighboring vessels.

A foreign body in the external canal, disease of the canal walls, irritation or inflammation of the drum-head, affections of the middle ear and Eustachian tube, contraction of the tensor tympani muscle, neuralgias, disorders of the stomach reflected through the inferior cervical ganglion, and disturbances of the cerebrum from medicines and disease, are all prolific causes of labyrinthine disorder and tinnitus.

Disease in the labyrinth from rheumatism, gout, syphilis, and other constitutional diseases is attended by local congestions, extravasations, and effusions, and causes so-called nervous tinnitus,

in which the per osseal hearing of the tuning-fork is always impaired.

The hallucinations of hearing, the vivid consciousness of some one uttering one's name when all is quiet, the hearing of whole bars of music after apoplexy, should all be classed with nervous tinnitus, because, if the otic end or the trunk of the auditory nerve is not affected, the cerebral percipient cells belonging to the nerve are.

Muscular tinnitus may be used to designate sounds from contraction of the muscles, connected directly or indirectly with the ear, but these hardly deserve the name of tinnitus, because of the long intervals between successive vibrations. Rapid spasmodic contractions of the tensor tympani have been reported as giving moist clicking sounds. The act of swallowing, by drawing the walls of the Eustachian tube apart, gives rise to another kind of clicking not so clear. Nothing is known of the action of the stapedius in causing tinnitus.

Vascular tinnitus is caused by the proximity of the internal jugular vein and the internal carotid artery to the resonant tympanum. The internal jugular is sometimes constricted by excessive deposits of ossific material in the jugular fossa; it is frequently dilated abnormally just beneath the base of the skull, owing to muscular development of the neck, and the habits of the individual. The carotid artery may be narrowed by bony encroachment upon its canal; it may be dilated into an aneurism without or within the skull; or its walls may be so degenerated by calcific deposits in the middle coat, as to destroy its elasticity, even, making it a rigid tube. With any of these variations in the blood channels it can be readily understood how normal blood, coursing upwards through the artery, and downwards through the vein at each heart throb, must necessarily make a friction-sound louder than that of health, and thus cause a tinnitus of almost invariable quality. I saw one case in which a squeaking noise within the cerebral space could be heard by placing one's ear upon the patient's temple. It was thought to be aneurism of the carotid at its division just inside the skull.

The position of the jugular vein and carotid artery, so near to the tympanum, permits the friction-sound of the normal blood-

current to be heard by an oversensitive ear, as one can prove by stopping the meatus with the finger. When these sounds are increased by alteration in the force of the blood, or by changes in its constituent elements, tinnitus of a mild character is produced. This is, however, true audition, as much as it is when sounds pass through the bones of the skull from a tuning-fork, vibrating upon the vertex. The conditions which cause this variety of tinnitus are anæmia, plethora, and heart disease. Thin, weak women are frequent sufferers from anæmic tinnitus, which is often increased by some catarrhal disorder of the tympanum. The purple-faced, thick-necked *bon vivant* is prone to throbbing, plethoric tinnitus, which is often a premonitory symptom of apoplexia. Persons suffering with valvular lesion of the heart and hypertrophy have an irregular and tumultuous circulation of blood and rhythmic tinnitus.

The prognosis will depend upon the cause. When this can be removed, of course, it is favorable; it may be stated in general, that the longer the noises have existed, the more difficult will it be to silence them.

Treatment.—The treatment of tinnitus is the removal of its cause, and, having made the diagnosis, the measures and medicines will be found mentioned in the proper place. Remove anything foreign or obstructive from the external canal, Eustachian tube and tympanum; inflate the ear with the air-bag, and treat diseases of the ear and throat *secundum artem*.

Aconite, in moderate doses, is the best equalizer of the blood circulation. When there are symptoms of vascular excitement, and hyperæmia of the brain and ear, especially, when acute inflammation is threatened, it will quiet the storm and relieve the tinnitus.

Belladonna is equally efficacious, when the congestion is confined to the head and face, and throbbing is a marked symptom. As a prophylactic of scarlatina, it should be preferred, if tinnitus occurs during the progress of that exanthem.

A sudden accession of tinnitus, fulness of the ears, and slight reddening of the membrana tympani, occurring particularly in a patient subject to torpid liver, who has lived in a malarial region, demands Cinchona as the nearest similimum. Tinnitus, con-

nected with catarrhal inflammation of the middle ear and Eustachian tube, is best treated by Pulsatilla and Kali bichrom.

Where the attacks are paroxysmal, and accompanied by neuralgia of the teeth, ear or face, Arsenicum is the best medicine.

The reflex noises and vertigo from gastric troubles yield to Arsenicum, Chamomilla, Lycopodium, Mercurius, Nux vomica, and Pulsatilla.

Hydrobromic acid has been used very successfully in 15-minim doses, largely diluted in water, by Dr. Woakes, of London.

Tinnitus, occurring with inflammation, effusion or hemorrhage in the internal ear, indicated by the tuning-fork upon the vertex and by other symptoms, ought to be treated by deep-acting remedies.

If it is recent, Mercurius cor. or Mercurius sol. should be given for many weeks. Another remedy may be substituted, if important symptoms demand, but one should return as soon as possible to the antiplastic mercury. Kali hydriod. is preferable for long-standing cases of labyrinthine mischief, and follows Mercurius very well.

Tinnitus, due to alterations in the elasticity or calibre of the large bloodvessels passing through the temporal bone, calls for Aconite, Digitalis, Kali hydriod., Secale and, in case of aneurism, perhaps, for ligature of the carotid artery. Compression of the carotid upon the affected side often arrests the noise temporarily.

Anæmia increases the friction-sounds of the blood in the carotid, and causes tinnitus of a cooing or humming sound. One can arrest it by compressing the artery, and thus confirm the diagnosis. Attention to the general health and the administration of Cinchona, Calcareo phos., and Ferrum met. will arrest the unpleasant symptom.

Plethora causes loud, throbbing, thumping noises in the ears through the carotid blood current, and is significant of danger. A patient consulted me for such a trouble, and a few weeks later had cerebral apoplexia. Be careful of the air-bag and inflate gently in these cases. Put the patient on low diet, and prescribe a glass of Friedrichshall Bitterwasser before breakfast, occasionally, alternating with Mercurius sol. until the engorged viscera

are relieved, and the bowels act freely. Then give other indicated medicines.

When the tinnitus arises from irregular vascular currents, and cardiac shocks transmitted along the vessels on account of heart disease, cardiac medicines are necessary, such as Aconite, Digitalis, and Veratrum vir., to moderate the circulation, and to control the ventricular contractions.

Many cases of tinnitus, which seem dependent upon extra-aural causes, will be found upon careful examination connected with some intra-aural mischief. For this reason the diagnosis must be carefully made, in order to direct to the proper therapeutic resources.

Acute Inflammation of the Tympanum.—This is inflammation of the mucous membrane of the middle ear and Eustachian tube, and varies in severity with the cause of the attack, and the constitution of the individual. It is probable that all serious inflammations of the tympanum are complicated by some extension of the disease along the Eustachian tube, though there are tubal inflammations in which the middle ear is not affected in a like manner. Mild catarrhs of the tympanum occur very frequently in our changeable northern climate, and attract little attention.

A person takes cold and has coryza or stiffness and dryness of the throat, for a day or two; the Eustachian tube opens with a rattle when he blows his nose; the ear feels a little full, contains a serous exudation, and has darts of transient pain; the hearing is somewhat blunted, and there is a mild tinnitus. The vessels along the malleus are injected, the membrana tympani is a little reddened and depressed, and the mucous membrane of the tympanum is hyperæmic. The cold gets better, the morbid symptoms of the ear disappear; or they drag along mildly and cause chronic catarrh and deafness; or increase in severity and cause constitutional disturbance and severe otitis. In the early stages, several inflations with the air-bag, a hot douche, and a few doses of Aconite, followed by Kali hydriod. or Pulsatilla, will usually favor resolution, and prevent serious injury of the ear.

Severe cases may begin mildly as serous catarrh, and gradually develop into mucous or purulent inflammation; but they are more likely to begin suddenly and violently.

Attacks are most frequent in the spring and autumn, and during changes from moderate to severe weather. It is rare that both ears are affected simultaneously ; the attack is generally confined to one ear at a time. The left ear is more liable to be diseased than the right, because the left Eustachian tube and left nasal fossa are generally smaller than the right. I believe the vomer is oftener bent in an elbow towards the left side, thus diminishing the left nasal fossa, because persons pull the nose to the right side when wiping it with the right hand. Wiping the nose is a constant employment with many persons in our northern climate during half the year.

The patient has his ear and throat exposed to a draft of air, a cold douche in a bath, or in the sea water while swimming and diving ; or he gets thoroughly chilled, especially, after vapor baths, and inflammation locates in the throat, tube and ear.

Eruptions of the teeth in infancy, and the wisdom teeth later, caries of the teeth, badly filled teeth, diseased gums, angina, diphtheria, whooping-cough, mumps, skin disease, syphilis, and exanthematous and typhoid fevers are potent causes of catarrhal inflammation of the tube and tympanum.

The pharyngeal end of the Eustachian tube sometimes becomes inflamed and its opening closed by swelling of the mucous membrane ; this prevents air passing into the tympanum, the air therein is rarefied by absorption, the drum-head is pushed inwards, the mucous membrane becomes hyperæmic and its secretions increased, the mucus of the tympanum and tube does not escape from the latter, it decomposes, irritates and inflames the middle ear, and may push the drum-head outwards again. In other cases, the inflammation does not wait for the tympanic affection produced by cutting off its supply of air, but travels up the Eustachian tube, extends along the lining of the tympanum, and causes considerable mucous secretion. Again, the inflammation is so violent, that the whole mucous tract from the pharyngeal end of the tube to the mastoid cells is swollen simultaneously, the spaces are filled with mucus, the throat is deeply affected, and the local symptoms are severe and constant. The mucus of these attacks is of complex nature. It may be sero-mucus or muco-purulent, and, perhaps, be mixed with blood. It may con-

tain white and red corpuscles, epithelial débris, and nucleated epithelium. It is quite fluid or very tenacious, and may adhere to the surface of the cavity. In chronic cases, it thickens and interferes with the action of the ossicles.

The consequences of the inflammation are rushing noises and throbbing in the ear, the latter often diminished by compressing the carotid; heavy aching pain in the side of the head, and sharp shooting pains from the throat through the ear and down the neck, sometimes mistaken for neuralgia. The pain is proportionate to the amount of exudation and swelling of the mucous membrane in the narrow confines of the tympanum; it is more severe when the disease tends to the formation of pus, and is always worse at night; there may be high fever, insomnia, restlessness, anxiety, loss of appetite, vertigo and delirium; between the exacerbations of the severe pain, the patient is generally weak and depressed.

Sound acting upon the membrana tympani, movements of the body and lower jaw, talking, coughing, sneezing, swallowing, eructations, and pressure around the auricle and throat increase the pain, sometimes, to an almost unbearable degree.

The hearing at the beginning of the disease is increased, but the swelling and exudation in the tympanum soon interfere greatly with the action of the drum-head and ossicles, and there is considerable deafness. This obstruction in the tympanum to the vibrations of the patient's voice prevents them from passing out through the external canal, and, as a consequence, the sound of the voice is augmented, it resounds through the head, and is often heard double. There is a sort of echo of each word or its last syllables, because the diseased ear perceives the sound a little later and of higher pitch than the well ear.

The tinnitus of acute inflammation of the ear is particularly distressing, and at first, consists of high musical tones, on account of implication of the cochlea. Later, soft blows from carotid pulsation are heard, and bubbling, cracking râles from movements of the exudation in the tympanum and tube.

The mucus or pus confined in the tympanum crowds into the mastoid cells, pushes out the membrana tympani, and pressing upwards, threatens to penetrate the brain case.

If now the ear be examined, the speculum will not cause any

pain when it is introduced, unless the canal is inflamed, which is seldom the case; the auricle can be moved, and the aural region palpated with impunity. Occasionally there will be soreness at the angle of the jaw, if the throat is affected, and swallowing will cause sharp stitches through the ear and neck. The membrana tympani looks smoky and dull; it has a lurid redness from the congested mucous membrane showing through the other layers, and from the injected bloodvessels, which run along the posterior border of the malleus handle, and pass from the canal wall all around upon its periphery.

Ecchymoses of small size sometimes appear in the membrane, and upon the inner end of the external canal, and are frequent in the subepithelial connective tissue of the tympanum. Hemorrhage is said to be frequent during such attacks, in patients suffering from Bright's disease of the kidney.

The triangle of light is altered in shape or has disappeared; the membrane is more concave than usual, in the early stages, but later bulges out in the part behind the malleus and threatens to rupture. The mucus in the tympanum can sometimes be seen through the membrane.

In severe cases, and those which become purulent, the membrane becomes moist and of a diffused cherry red, the light triangle and manubrium are obscured, and it is very liable to rupture spontaneously or from a slight shock such as is caused by strong inflation or rough syringing.

Burnett thinks catarrhal cases do not rupture, while purulent ones do, and non-rupture and rupture are considered diagnostic signs of the two varieties. I cannot confirm this nice distinction. The difference between the mucus and pus of acute inflammation of the middle ear is more apparent than real. Mucine and bluish-white corpuscles, albumen and yellowish-white corpuscles, express the relationship and difference.

The cases of uncomplicated acute inflammation of the middle ear with perforation of the membrane, which I have had under observation at the time of rupture, have always discharged mucus at first, and pus very soon afterwards, unless recovery has followed closely after the discharge.

One can sometimes prophesy from the constitution of the patient

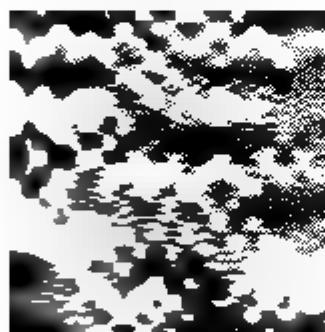
and the character of the inflammation, whether or not, the discharge will become purulent.

In blonde, lymphatic, anæmic or scrofulous persons the flow from the ear is, at first, quite thin mucus, but it soon changes to pus. These patients furnish many perforated membranes and long, tedious and destructive suppurations.

In brunette, bilious, plethoric, and fibrous individuals the discharge often remains thin mucus until recovery ensues, though, of course, pus may follow. These constitutions show many cases in which perforation does not occur, but chronic proliferous inflammation is likely to be left as a sequela.

In some cases, it seems as if the moment the air gets to the middle ear through the perforated tympanic membrane, the catarrhal secretion is changed to pus. Sometimes one sees through the speculum the lower third of the outer surface of the mem-

FIG. 74.



BULGING OF THE MEMBRANA TYMPANI FROM EXUDATION (Schwartz).

brana tympani obscured by a little pus, which has flowed through some minute rent in the membrane, or has come from sympathetic disease in the canal.

The posterior inferior quadrant of the membrane may bulge from the intra-tympanic pressure, though the anterior inferior portion, and the membrana flaccida of Shrapnell are occasionally somewhat prominent.

The projecting cone of the membrane, caused by mucus or pus behind it, is a lighter red than other parts of the membrane. Sometimes pure blood in the tympanum gives the whole membrane a dark red color.

When the membrane ruptures, it first becomes light, thin, opaque, and finally opens by a round hole, and the fluid contained

in the tympanum flows outward. The edges of the opening are red and swollen, and a little blood and pus are seen upon the surface and at the bottom of the canal. The rupture occurs usually in the posterior inferior or anterior inferior quadrant, but occasionally a minute opening may appear in the flaccid part, above the short process of the malleus.

Before rupture, the diagnostic tube and inflation will give mucous râles, consisting of rattles and gurgles of unmistakable nature. If they sound clear and sharp, and come quickly, they originate in the tympanum; if the sounds are duller and come slower, they arise in the Eustachian tube. After a small perforation has occurred, the air will hiss or whistle freely out of the ear on inflation; if the opening is large, there will be a coarse puffing sound, and some discharge will be forced into the external canal.

The severe symptoms of this disease are so rapidly ameliorated by the giving way of the tympanic membrane, that artificial perforation is now considered a legitimate operation in all severe cases. It relieves the intense pain in a marvellous manner; hastens resolution, and diminishes the danger of permanent deafness, caries and other complications. The operation is simple, and the wound often closes rapidly, so that generally the tympanum and membrane are restored to a normal condition sooner and surer, than when reliance is placed upon the usual treatment, without the surgical procedure.

When rupture does not occur, and paracentesis is not made, recovery may take place in a shorter or longer time, but if there has been much mucus or blood in the tympanum, as recovery takes place, its water will be absorbed, and dry, adhesive, contracting masses will cling to the ossicles and other parts. These cause adhesion of the membrane, stiffness of the ossicular joints, and progressive, incurable deafness, so that paracentesis in all severe cases is necessary for the integrity of the ear.

Paracentesis of the membrana tympani is indicated in acute inflammation of the tympanum: when the pain in the ear is very severe; the drum-head bulges at any part; there is evidence of mucus, pus or blood inside the membrane; the Eustachian tube is solidly obstructed; the catarrhal attack is grafted upon a tym-

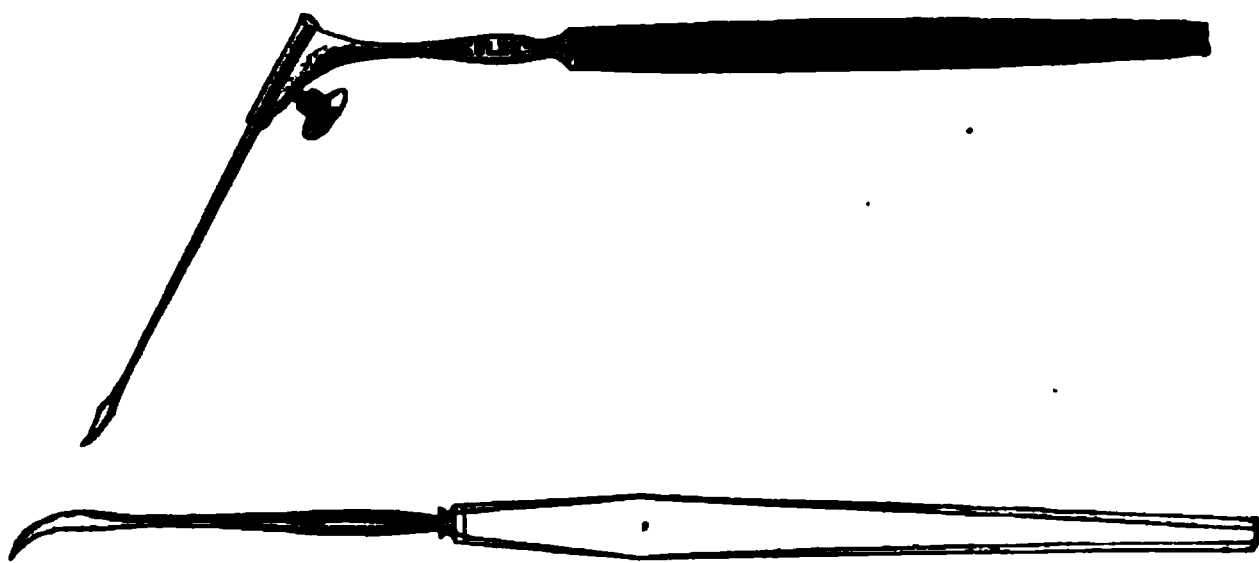
panum in a condition of chronic disease, and the usual treatment does not afford relief to the severe symptoms.

Various instruments have been employed to perforate the membrane, as the actual cautery, galvano-cautery, trocar, blunt probe, bistoury, and lance-shaped knife. A linear incision, an irregularly dissected hole or a round cauterized perforation is made, according to the desire of the physician.

The simplest way is always the best, and I prefer the myringotome, a lance-shaped knife with a shoulder, fitted in a straight or in a Weber-Liel handle at an angle, so that it permits full illumination of the membrane during the operation.

The incision should always be made in the inferior half of the membrane, because an incision above this is liable to injure the tympanic pouches, cut the chorda tympani, fracture the ossicles,

FIG. 75.



MYRINGOTOMES.

and excite severe inflammation. The inferior posterior segment is the best place for operation, as the membrane here is farther removed from the inner wall of the tympanum, than it is in front of the manubrium. Fortunately the bulging from intra-tympanic pressure occurs here most frequently, though it is seen occasionally in front of the manubrium.

A simple puncture in the prominent part of the membrane or an incision of 2 to 3 mm., extending from just behind the end of the manubrium to the lower border, may be made. If the membrane is depressed, and adherent to the ossicles, or inner tympanic wall, it would contraindicate the operation, unless under very exceptional circumstances.

Introduce a hard rubber speculum, put on the head-mirror, illuminate the membrane well, and push the knife through at the selected point to its shoulder, then remove the instruments, syringe gently with warm water, and inflate by the air-bag once or twice, with the patient's head bent towards the side diseased. If this does not empty the tympanum, inject through the opening of the drum-head by a syringe with a delicate nozzle, bent at an angle near the point. At the moment of perforating, one feels as if cutting thin parchment, and hears a delicate rattle. If the ossicles and internal tympanic wall are not touched, there is only slight pain experienced by the patient, and very soon a blessed relief from the severe pain of the otitis comes.

There is usually a flow of sanguinolent mucus into the canal, and the edges of the cut bleed freely for a little while, on account of the congestion of the membrane from the disease.

The next day, the edges of the wound appear swollen, and a little pus clings to them and to the membrane. A little mucopus is usually found flowing through the wound, and more can be forced out by inflation, if the Eustachian tube is pervious. If recovery now ensues, the symptoms will all ameliorate, the fullness and discharge cease, the membrane close by a slender white cicatricial line, and hearing improve with the restoration to health.

Frequently so happy a termination is not early attainable. The symptoms are likely to continue less severe; the discharge becomes purulent and copious, and the case drags along some weeks till cured, or it lapses into Chronic Purulent Inflammation.

This description applies more particularly to persons old enough to give rational answers to questions, and whose ears can be examined partially through the throat, and the external auditory canal.

There are some peculiar symptoms connected with acute otitis in infants, which demand especial consideration. A babe without articulate language cannot help a physician to a diagnosis, any more than a wild beast of the forest can, and he must use acute observation, instead of his bedside catechism, if he would find out what is the matter with "mother's darling."

The causes of acute inflammation of the middle ear above enumerated are mostly prevalent and potent in infancy, and their effects are more dangerous than in adults.

It is the general opinion of aural surgeons, that many cases of infantile otitis are unrecognized by the family doctor, and that the little patients are treated for everything but the otitis.

From the statistics of our deaf and dumb asylums, showing the cause of deaf mutism in a large proportion of the cases to have been neglected diseases of the middle ear, generally regarded as curable if seen early; and from the mysterious cerebral complications and unaccountable deaths of tender buds of promise, it is probable the opinion is far from wrong.

The ear, as well as the eye, ought to be examined in all cases where there are symptoms of cerebral irritation, especially in children unable to correctly locate their sufferings.

Some children have running from an ear every time a tooth cuts through the gum, owing to irritation transmitted to the ear through the otic ganglion.

Teething and carious teeth frequently cause sore gums, ulcers in the mouth and throat, and swollen pharyngeal glands and tonsils. These excite disease of the ear very readily by contiguity and extension of the disease along the mucous membrane, and the primary cause is little suspected unless careful examination is made.

The very delicate walls and mucous membrane of the middle ear of the infant; the undeveloped mastoid process, with the horizontal concavity below the tympanum for retaining secretions; the veins from this region to the lateral sinus; the liability to caries of the small cells and the roof-plate just behind and above the inner end of the external canal, upon which the middle lobe of the brain rests; the danger of phlebitis, meningitis, cerebral abscess, and pyæmia; all these, make it imperatively necessary to recognize the disease early and to treat it actively.

The poison of measles and scarlatina is frequently eliminated from children mostly by the way of the mucous membrane, instead of by the skin; and the eyes, nose, mouth, throat, Eustachian tubes, and the tympanum are often in a condition of severe catarrhal inflammation. The amount of fluid discharged from

the nose and throat in such cases is remarkable, and chronic disease of these parts is a frequent sequel. The ears are more liable to be permanently injured than the other organs, because the exudation ruptures the membrana tympani, and a permanent purulent discharge is established.

Very often the alarming cerebral symptoms, which supervene during the course of an acute erythematous disease, are due entirely to the sudden onset of inflammation in the middle ear. The ability to detect such complication will not only bring relief to the patient from suffering and danger, but, also, lift a load of anxiety from the minds of ministering relatives, and give the physician that calm confidence, which comes alone from thorough knowledge.

From the neglect of the family doctor to treat such cases, the incurable organic lesions result, and a foundation is laid for many a case of deaf-mutism and, perhaps, death. I never see an infant's ear full of pus, but I shudder at the thought of the possible consequences.

An infant manifests febrile reaction and restlessness, when the middle ear becomes affected, whether the inflammation travels up the Eustachian tube, or affects the tube and tympanum simultaneously. The pain and fever are worse at night, but finally continue through the day, and the patient cannot be quieted. He rolls about in bed; tosses the head here and there; buries it in the pillow; carries one hand now and then to the top of the head, the temple or aural region of the affected side; whining, crying or screaming almost all the time.

In severe cases, the screams are piercing and heart-rending, resembling the *cri encephalique* of meningitis, and delirium, spasmodic contraction of groups of muscles, and, even, violent convulsions are not uncommon. It is next to impossible to examine the membrane or the naso-pharynx of babies, but the history of the case, and a view of the throat will cast some light upon the diagnosis.

If by any management the drum-head can be seen, it will be found depressed, and of a dull gray or pink color, and the aural region will be a little hypersensitive. When suspicious of ear disease, hold the child, fill the external canal of the suspected organ with quite warm water, renew every few minutes for half an hour, and inflate the tympanum several times.

If the ear is attacked, the measures will relieve the congestion, push out the drum-head and ease the pain, as well as confirm a doubtful diagnosis. The external auditory canal should be inspected with speculum and mirror, as the presence of a mucous or purulent discharge may settle the question instantly, though this does not generally appear until after some days of suffering.

Then the membrana tympani has ruptured spontaneously, but the opening is not large enough, or the swelling has occluded the inner end of the canal, so that the exudation is still somewhat impeded in its outward flow.

When the true condition of the ear is ascertained, the proper treatment will be obvious. Paracentesis of the membrane should not be attempted too soon in children; not until all other means of relief have proved futile, and the sufferings are severe.

After the full description given of acute inflammation of the tympanum, it is not necessary to say much in regard to diagnosis. It is seen so often, that every physician ought to be very familiar with its salient points.

The history of the onset; the condition of the throat and mouth of the Eustachian tube, as revealed by an examination with the laryngeal mirror; the appearance of a hyperæmic, perhaps, bulging or perforated membrana tympani; the deafness, tinnitus and severe pain, all indicate the aural mischief which is brewing, and call for immediate and active treatment.

The prognosis is favorable, if the patient is seen early, and the physician knows what to do, and how to do it. The hearing in mild cases is usually fully restored, but in severe ones is sometimes reduced to hearing the watch one or two inches, which permits a fair comprehension of medium voice conversation. Judicious treatment will generally prevent perforation and adhesion of the drum-head, and the tympanic and cranial perceptions, though quite obtuse at first, will gradually return. After one attack of inflammation there is liability to relapse, and frequent attacks may totally destroy the membrana tympani, or if it heals readily, may thicken the mucous membrane of the tympanum over the round and oval windows, and stiffen the joints of the bones even to ankylosis, so that hearing may be greatly impaired. For these reasons the physician must be careful to understand the

exact state of the ear before giving a decided opinion in regard to future hearing.

Treatment.—The early treatment of this disease should not differ materially from that of otalgia. The patient should be kept quiet in bed, with the painful ear uppermost, and the head, ears and neck covered by a flannel cap; he may eat marshmallow drops slowly, have milk toast and currant jelly, and be permitted to drink freely of cold lemonade. Remove the cause if apparent; lance swollen gums, and pull out painful teeth. The infant should be fed with a spoon, and not allowed to suck. Heat a quart of water to a temperature of about 100° or until it feels decidedly warm to the bare wrist, as the hand is too much blunted by exposure to appreciate the proper temperature for an aural douche. Use the fountain syringe if possible, and inject the ear gently for five or ten minutes. The steady flow of the fountain is more agreeable to a painful ear, than the intermitting jets of a hand syringe.

One may steam the ear with hot water alone or containing a little vinegar, using the special steam apparatus figured under Chronic Inflammation of the Tympanum and Tube.

In all cases, if the patient is old enough, he should gargle the throat with hot water, having one part of alcohol to three of the water, or with what I consider better, a hot saturated solution of chlorate of potassium. A tablespoonful of Cinchona tincture to a glass of water is an efficient topical agent of considerable power, when the mucous membrane is relaxed, and the veins are full. Twenty to thirty grains of Sodium salicylate in a glass of water should be preferred, when the throat is suffering from Scarlatina or Diphtheria.

Gargling causes contraction of the muscles about the Eustachian tube and mechanically clears the tube of mucus, it stimulates the mucous membrane to healthier action, and the alcohol and chlorate of potassium have an antiseptic influence upon the parts. Spraying the naso-pharynx with these fluids in an atomizer is another excellent method of treating the tube and ear.

Inflate the ear with the air-bag alone, or, if difficulty is experienced and the patient is old enough, in conjunction with the catheter, until it is certain the air has gone into the tympanum.

This should be done several times a day, during the acute stage, and once a day, during the subacute.

Inflation improves the hearing for awhile, relieves pain often, separates the diseased surfaces of the tube and middle ear temporarily, displaces mucous masses, favors discharge into the pharynx, and prevents adhesions. There is no danger of forcing the catarrhal secretions into the mastoid cells, as once taught, by inflation during acute aural inflammation.

Aconite is one of the best medicines for acute inflammation anywhere. It is indicated in a large proportion of these cases, as they have more or less vascular excitement, and peculiar ear and throat symptoms. Those that I have confirmed are: Sore throat with sharp pain running along the Eustachian tube to the ear; sudden pain in the ear with sudden deafness; violent pain in the ear and all over the side of the head, with vertigo, faintness, and slight delirium; dryness and burning pain in the throat, with dull pain and fulness of the ear; pain in the ear and deafness, appearing during an exanthematous disease.

Belladonna has a wide pathogenesis. In a limited number of cases of acute otitis, the localized congestion, pulsating carotids and cerebral excitement will certainly lead the philosophical practitioner to select this medicine.

It is demanded, when the throat is dry, bright red, raw and swollen; there is constriction, constant inclination to swallow, and more or less engorgement of the tonsils and lymphatic glands. The piercing pains are inconstant and erratic, occurring in the external meatus and mastoid, then shooting from the throat to the ear, and again darting through the temporo-maxillary articulation, the parotid, the temple, orbit and occiput.

Pulsatilla does excellent service in milder cases, complicated by considerable catarrh of the naso-pharynx. One should consider it when chilliness alternates with flushes of heat, and sometimes sweat; there is a raw soreness of the throat, with venous congestion of the pharynx and fauces, and some clinging mucus; fulness of the ear; deafness and tinnitus, accompanied by paroxysmal stitches of pain through the ear, and an early discharge of bland, light colored muco-pus.

Bryonia is useful when the ear affection is less prominent and

complicates a general rheum, characterized by chilliness, fluent coryza, sore throat and chest, muscular and articular soreness, stiffness of the neck, fulness, tinnitus and dull pain in the ear.

These medicines are sheet-anchors in acute otitis, and few cases resist their beneficent action, when used in conjunction with other necessary measures.

I deprecate a resort to Morphia, as less efficient than these medicines; it is a mere palliative, that prolongs the disease and is dangerous to life.

If my whilom friends in Galenic ignorance will lay aside their prejudices, and treat a few cases of otitis media with the lucid tinctures of the new school, they will abandon the repressive and oppressive methods of treatment inculcated by their masters, who were once mine, and rise to a higher plane of usefulness amongst their fellow-men.

After the selected medicines and the above measures have been tried awhile, if the pain continues, make a strong hop tea, have it as hot as can be borne, and douche or spray the ear gently with it for several minutes at a time. Should the pain not be ameliorated by this in half an hour, and the membrana tympani be intact, put ten drops of Aconite tincture in a teaspoonful of hot water, have the patient incline his head towards the well side, fill the canal of the affected ear with the dilution, let it remain in till cooler, and then renew if necessary. Continue this, the internal medication, and the occasional inflation for some hours, when relief and, perhaps, entire arrest of the morbid process may result, though the drum-head may rupture in the interval. If such a happy result is not attained, the symptoms continue violent, and the membrana tympani is bulging, be it ever so little, a bold paracentesis of it should be made, and a light inflation follow. This operation is more rational and safer than a resort to Morphia or Atropia, as mentioned under Ootalgia. Any discharge into the external canal is to be washed out by delicate syringing with the hop tea, and inflation is to be practiced several times a day, as long as the discharge remains.

If pain continues after paracentesis of the membrane, use the hop solution hot till it ceases, and then, as the discharge diminishes, substitute a wash of Alcohol, one teaspoonful to an ounce

of warm water, which will stimulate the mucous membrane and drum-head to recovery. Above all do not, yet, use astringents, as they irritate and renew the inflammation.

It is altogether probable that some of these measures employed will diminish the suffering and violence of the disease, cause early resolution, and restore the ear to a useful, if not to a perfect physiological state.

The acute stage lasts from a few hours to several days, according to circumstances. If the membrana tympani does not rupture, and is not artificially perforated, or the inflammation extends to the mastoid cells, it may be much prolonged. I have discussed the latter complication under mastoid disease, in order to present together all the varieties of disease of that process.

Sometimes symptoms of the declining stage demand other medicines. Hepar is indicated by aching in the ear, worse in the cold, a discharge of pus, redness and swelling of the mastoid, and tumefaction of the lymphatic glands. Kali hydriod. is needed when the discharge becomes serous and thin, and chilliness and aural pain threaten a recurrence of the acute symptoms.

After the discharge has ceased, should the perforation in the membrane not heal, it should be treated according to the directions under Injuries of the Membrana Tympani; and the treatment of sequelæ, such as Chronic Purulent Inflammation and Mastoid Disease may be found under their respective headings.

Chronic Purulent Inflammation of the Tympanum.—Attacks of acute inflammation of the tympanum frequently result in perforate membrana tympani, and a muco-purulent discharge, as above described. When the acute symptoms have passed away, but a restoration of the ear to a normal condition does not ensue, and the purulent discharge continues on week after week, the stage or state comes properly under the title that heads this section.

This is the aural disease most frequently seen by the general practitioner, who has not paid attention to ear affections, is not able to cure the patient and, hence, readily falls into the old women's notions, that "a running ear must not be stopped;" "the discharge will purify the blood;" and "the afflicted one

will outgrow it after a while." Every one of these statements is false, and no physician should lend his countenance to them.

Diseases of the ear left to themselves lead to very bad consequences, aside from the constant menace which they are to the life of the individual. Many children have lost their hearing through the destructive processes of a curable ear disease, and have been sent at last to an asylum for deaf mutes, to be educated, because of the thoughtlessness of parents, and the carelessness of the family doctor. Look at the reports of institutions for deaf mutes and be shocked at the number of inmates, who present aural conditions now, which clearly show that had they been treated early, the ear diseases could have been arrested or cured, and the patient have had good enough hearing for the purposes of business and life.

Ear diseases of every kind and degree should be treated faithfully, and the earlier the better; because scientific medicine commands, and the reports of deaf and dumb asylums and revelations of the dead-house admonish us to do so.

I shall never forget the anguish of a strong man, who came to consult me about himself, when he had related a clear history of mastoid disease, following a chronic suppuration of the ear in a lady, and asked what treatment I would have advised. As I told him briefly the necessity for trephining to diminish pressure, liberate pus, and prevent cerebral complications, his eyes filled with tears, and when I had finished, he cried, "Oh! my God, what my poor wife suffered, and how she was maltreated! Nothing but morphia, morphia, morphia, until her dear head burst!"

I am not prepared to indorse Burnett who says, "Unless the otorrhœa is cured the disease will surely extend to the brain. If it does not reach the brain, it will be because the patient will die of pyæmia and metastatic abscesses, before the central organ in the skull is reached."*

This is too pessimistic, and is emphatically contradicted by experience. I have seen cases of suppurative inflammation of the tympanum of forty years duration, with the hearing sufficiently

* The Ear, Its Anatomy, Physiology and Diseases, Burnett, p. 474.

good for enjoyment of conversation, music, etc. There are plenty of cases applying for treatment with otorrhœas of from five to ten years duration and hearing tolerably good, and deaths from aural disease are not very common, even, when the patient has had no treatment whatever. It is now believed, however, that many reported deaths from cerebral disease, pyæmia, etc., were, in truth, caused by a non-suspected or untreated ear disease. I think it would be more reasonable and correct to say, that suppurative inflammations of the tympanum are offensive and troublesome, are slowly destructive of the auditory apparatus and hearing, and sometimes prove dangerous to life itself. From these facts it follows, that treatment should be thorough and persistent till cure results.

The causes of chronic purulent inflammation of the tympanum lie behind those of acute tympanic inflammation, and are constitutional, such as scrofula, which influences the character and degree of the affection, as before mentioned; and morbid, such as the presence in the system of the diphtheritic, morbillous, scarlatinal, variolous, syphilitic, and typhoid poisons.

Whatever the condition of the blood in the exanthematous diseases, they all express themselves by inflammatory processes of the skin and mucous membrane. These should be affected in a certain proportion, if the disease follows a natural course, but this is not always the case, as every physician knows to his sorrow. The analogies between the inner lining and the outer envelope are such in anatomy and physiology, and their vicarious action is so easy, that we can understand how a morbid fluxion may vibrate between them, now affecting one and now the other, with more than its share of the task of elimination.

The nature and situation of the mucous membrane in the nasopharynx, Eustachian tube and middle ear render its inflammation there especially injurious to structure and function. One can now understand how, when measles, scarlatina, etc., do not develop their characteristic eruptions upon the skin, they may produce severe and dangerous inflammation of mucous surfaces, which in the ear does not always terminate with the exanthem and the acute attack, but continues as a chronic purulent disease of great obstinacy. I look upon some of these purulent otorrhœas

of recent origin, as morbid fountains of elimination for disease germs or products, which have not been extruded from the system during the acute exanthem; but later, they are both cause and consequence of their own existence—the diseased mucous membrane keeps up the morbid discharge, and this irritates and sustains the disease of the tympanum.

The relation between acute diseases and chronic purulent inflammations of the tympanum may be seen from seventy cases of the latter, treated by myself during the last three years, of which careful records have been kept. Of these, one was caused by variola, two by diphtheria, two by typhoid fever, nine by measles, nineteen by scarlatina, and thirty-seven by colds.

Colds inflame the naso-pharynx in many cases, and by extension of the inflammation to the tympanum, cause the greatest number of chronic suppurations of the tympanum.

Scarlatina is the next most prolific cause, and this is exactly what one would expect who remembers the severe angina with which this formidable exanthem is usually ushered in. The throat inflammation is limited in area and intensified, and tends to infarction and phlegmonous swelling of the connective tissue. These greatly interfere with the functions of the parts and disappear slowly.

Measles differs from scarlatina in its affinities and pathology. The mucous membrane of the eyes, nose, throat, larynx, trachea and bronchial tubes are irritated and inflamed; the morbid influence is thus diffused and rendered milder, so that, with profuse mucous discharge, the danger of local disease is diminished, and amelioration soon follows. Measles probably causes more inflammations of the tympanum than scarlatina, but they are milder. Many terminate without rupture of the membrana tympani, and thus the proportion of chronic suppurations is less, and those which do appear are more manageable.

From the few reported cases of chronic suppuration caused by typhoid fever, variola, and diphtheria, one would conclude that they exercise little influence upon the ear. Probably the statistics of other diseases, such as rheumatism, pleurisy or tuberculosis would show as many, so that one would suppose them to

be accidental, rather than causative. Statistics are sometimes very unreliable.

Typhoid fever affects the integrity of the ear very early in its course, and every practitioner knows how the hearing diminishes as the mental hebetude increases. This has been charged to torpor of the sensorium, and to invasion of the labyrinth by the altered sub-arachnoid fluid, passing through the aquæductus vestibuli and the porus acusticus. While these statements are reasonable, and in accord with scientific investigation, observation has made prominent the fact, that the middle ear is much more frequently affected during the course of typhoid fever than formerly supposed, and that some of the deafness—to speak guardedly—observed in the disease, depends upon morbid processes in the tympanum.

A considerable number of my patients have dated their aural lesions from attacks of typhoid fever, and nearly all of these have heard the fork well, when placed in vibration upon the vertex, and presented symptoms of disease of the tympanum.

I called the attention of Dr. W. J. Martin, of Pittsburgh, Pa., to this subject, during an epidemic of typhoid fever in his neighborhood, and requested him to make certain observations. He kindly consented, and furnished me with valuable data.

In a period of twelve weeks, the doctor treated seventy-two cases of typhoid. He says: 'There were fifteen cases that might be called light, having no delirium, diarrhoea nor any bad symptoms; the temperature never getting above 103°. None of these cases had any deafness or disease of the ears.

'The other fifty-seven cases might be classed as severe, and very severe. By the latter, I mean cases in which the temperature rose above 105°, and there were marked cerebral symptoms, with intestinal or uterine hemorrhage. Of these fifty-seven cases, twenty were more or less deaf; five were very deaf, even to loud shouting.

'These five patients had the longest continued high temperature, ranging from 105° to 106½° F. The deafness increased with the temperature, becoming marked after the patients had had a temperature of 104° F. for several days; in most cases, it diminished with the decline of the disease.

‘It persisted in a few persons in a moderate degree, and in one patient, markedly some time after the temperature had become normal.

‘The patients complained generally of a roaring in the head like the sound of water falling over a precipice.

‘Those having deafness were not all delirious, nor were all the delirious patients deaf. The cerebral type of the fever furnished most cases. When abdominal symptoms predominated, deafness was less frequent and less severe. I think the twenty cases with deafness were more seriously ill, than the thirty-seven without.

‘All my fever cases recovered except one, a woman who had been delirious and deaf; after recovery from the fever, she died of gangrene of the left side of the face.’

‘In answer to questions propounded, I received some additional information. All the persons with aural symptoms considered their hearing good before the fever commenced, though two had some ear disease.

‘Two patients became deaf on one side only and that the right; the others had both ears equally affected.

‘None had noticed any noises or itching in the ears before they were prostrated by fever. About half of the patients could hear medium voice, the rest loud voice.

‘Several had otalgia accompanying slight deafness; two had acute inflammation of the tympanum, with purulent discharge from the meatus. Five persons remained deaf during convalescence, later the number was reduced to three. Of these, one has a purulent discharge from the ear, and the other two have chronic inflammation of the tympanum. All the other patients consider their hearing as good as previous to their illness.’

It is evident that typhoid fever furnishes a considerable percentage of ear diseases, though not nearly so many as the exanthematous fevers. In a fair proportion of cases, the tympanum is the part attacked; other cases, especially, with binaural deafness, corresponding in severity with the disease and the increase of temperature, and disappearing during or soon after convalescence, are due to depression of the nervous system, and alteration in the quality of the sub-arachnoid and labyrinthine fluid.

It is rather remarkable that diphtheria, manifesting its morbid

action in the throat, does not affect the ears *more* frequently, but the reason may be found in the positions of the membranous formations, which are generally upon the soft palate, the palatine arches, and tonsils.

Whatever the primary cause of the aural inflammation, the strumous constitution presents the defective blood and undervitalized tissues, which sustain the morbid action, nourish abnormal growths, and favor destructive processes. Non-scrofulous cases are soon cured or dead, but scrofulous ones tax the resources of the materia medica and medical skill to the utmost.

A person with a suppurating ear is likely to be dull, depressed, melancholy, taciturn, forgetful, idle, lazy, partially deaf, and incapable of proper use of his intellectual faculties. Many children, and adults too, are thought stupid, ignorant, and obstinate, because their hearing power is impaired, and the brain and body are irritated and weakened by the existence of a purulent inflammation in the middle ear.

Kramer believed that ear diseases were almost always local, but wider experience and knowledge prove them to depend, in many instances, upon a constitutional dyscrasia, such as scrofula, rheumatism or gout.

One patient may look robust, but be conscious of weakness and malaise after exertion, and feel mental labor too heavy a burden. Another may be tolerably healthy in appearance, have disturbed digestion, palpitation of the heart, muscular debility and loss of energy. Another, still, may be anæmic, pale and thin, have weak pulse, shallow respiration, loss of appetite, disgust for fatty food, great weakness, alternately pale and flushed face, and hectic of chills, fever, delirium, and night-sweats.

Albuminuria is found in many acute and chronic diseases, and is present in some cases of chronic suppuration of the tympanum. This is probably a mere coincidence, the disease of the ear and the irritation of the kidney being sequelæ of some one of the exanthematous diseases.

The patient with purulent inflammation is always below par, and the state of health is generally worse, the greater the amount of suppuration.

Children furnish more cases than adults; erythematous dis-

eases produce many, which get well spontaneously or are cured by proper treatment in youth, demanded from physicians by anxious mothers. Adult cases are the survivals of the fittest and untreated, and the sequelæ of colds from exposure to all weathers, climes, and adverse circumstances. Males are more afflicted than females, both early and late in life, because careless of their health and, especially, of their ears at all times.

This disease depends upon the constitution of the patient for its grade of symptoms, just as does acute inflammation of the tympanum, where the effusion within the ear may be serous, mucous or purulent. Clinical experience of this most common affection in the whole range of aural diseases demands a recognition of these grades, in order to arrive at a scientific and successful treatment. For descriptive purposes, I consider there are three conditions which require individualization, though of course there are many intermediate.

1. Inflammation characterized by a very slight secretion of muco-pus, not enough to flow out of the canal, but sufficient to accumulate in the ear and canal, and form closely adherent fetid crusts. These irritate the parts in contact, cause small granulations, contractions, and adhesions; diminish the hearing; induce tenderness and occasional pains, and predispose to acute exacerbations.

2. Inflammation attended by a moderate flow of tolerably healthy pus out of the external meatus, varying in quantity from a few minims to a teaspoonful or two in the twenty-four hours; medium-sized granulations and, perhaps, the firmer kind of polypi in the tympanum; variations in the hearing, dependent upon the quantity of pus in the ear, and the degree of moisture in the atmosphere; a tendency to slow hypertrophy of the aural tissues without acute symptoms, and a liability to aggravations and mastoid disease.

3. Inflammation, causing a profuse flow of illaudable, acrid, yellowish-green pus, often containing blood and brownish particles of bone, which excoriates the lower wall of the canal and meatus. It causes rapid ulceration of soft tissues and, sometimes, caries of the bone, paralysis of the facial nerve, the formation of flabby granulations and large soft polypi, and greatly diminishes

the hearing power. This variety is very common, difficult to cure because grafted upon a strumous constitution, frequently dangerous to life, and makes aural surgery a necessity.

The local symptoms vary with the pathological conditions of the ear. The prominent ones are deafness of some degree, the presence of disagreeable smelling pus in the ear, increased sensitiveness of the external auditory canal, some soreness, occasional darts of pain through the aural region, slight and temporary attacks of vertigo, lateral headaches, and, perhaps, fever and delirium.

The hearing is always defective, and should be tested by voice, watch, and tuning-fork. Interrogations of a patient's perceptions of the tuning-fork, vibrating upon the vertex, will bring answers in regard to the condition of the labyrinth. If the disease has merely caused hyperæmia of the internal ear, the sound of the fork will be heard somewhat muffled. If the labyrinth is seriously affected by extension of the tympanic disease inwards through the many channels of intercourse, the hearing will be, of course, diminished proportionately or, perhaps, entirely annulled.

When the labyrinth responds well to the vibrations of sound through the cranial bones, though the tympanum may be considerably diseased, the patient may hear the watch from three to thirty inches. With good cranial perception, and a hearing power rising occasionally to two or three feet, one can promise a restoration sufficient for the usual demands of mundane existence, provided the morbid discharge can be arrested.

A thick slowly flowing pus, tending to form clots and crusts, to retard the discharge of epidermic shreds, and to accumulate dust and foreign bodies; considerable congestion and thickening of the mucous membrane; an exuberant formation of spongy granulations and, perhaps, polypi; a small perforation of the membrane retaining inspissated pus in the tympanum; closure of the Eustachian tube, a rumbling or rhythmic tinnitus, and damp weather, all diminish audition, and most of them favor destructive and dangerous complications.

The external meatus or the canal deeper in contains pus. It is thin, creamy or jelly-like; stringy and thick, bluish-white, yellowish-white, yellowish-green or gray and sanious. The

younger the patient, the lighter the complexion, and the more recent the disease, the more copious will be the supply. The discharge is generally slight and thick in adults, likely to form masses and to adhere to the border of the drum-head and the walls of the canal and tympanum, and thus obstruct the outward flow.

The discharge may have a faintly disagreeable earthy odor or be fishy, foul, disgusting, and corrosive. In caries of the temporal bone, the smell of the discharge is sickening and almost diagnostic of the condition. Cleansing the ear frequently will diminish the foulness of a necrotic discharge, but deep wiping with cotton will bring out a relic of rottenness, offensive enough in odor.

Red haired struma takes the premium for illaudable pus, which often causes considerable destruction of the skin in and around the ear. The worst suppurations are those following scarlatina and measles, but the constitution modifies it much.

A solution of subacetate of lead is blackened by this pus, on account of the sulphur that it contains, and a sulphide of lead is formed. Congestion of the tympanum often gives the pus a pulsating motion, synchronous with the action of the heart.

The purulent discharge of ordinary cases contains pus cells, free and aggregated in masses; compound granule cells and shreds; crusts of dried pus and epithelium; hairs and altered cerumen; dust and dirt from without, and, perhaps, blood and particles of bone. Blood is seen mixed with pus, when a purulent tympanum is wiped out by the cottoned probe, and the débris of bone from caries appears as little brown particles. If the ear has not been cleaned for a long time, fatty pus cells, cholesterine crystals, and flakes of epithelium are found in the tympanum, clinging tenaciously to the depressions and openings.

Tinnitus is not very common in this disease. When the canal walls are congested, swollen, and narrowed; masses of pus and epithelium have accumulated; crusts, exuberant granulations or polypi block the lumen; the drum-head has a small perforation, with pus behind it; or there is some functional or organic change in the great vessels contiguous to the ear, there is likely to be tinnitus of varying quality and intensity.

Pain of some kind is present in about half the cases. There may be merely soreness to the touch, especially, if the parts have macerated in the pus for some time. When the disease is of long standing, and the discharge is only sufficient to fill the tympanum and form crusts by drying, the pain on contact is sometimes excruciating. Sharp stitches sometimes shoot through the diseased ear; moderate steady pain accompanies caries of the temporal bone; and the side of the face is sometimes distorted from paralysis of the facial nerve.

Cases of chronic purulent disease of the tympanum are subject to acute exacerbations at times, the pain may become severe and persistent, and there may be many of the symptoms of an acute primary inflammation. Relief is afforded by giving the indicated medicine, and by clearing a passage for the pus out of the external meatus, as it rarely escapes from the ear by the route of the Eustachian tube.

Tenderness and pain are experienced in front of the tragus, below the auricle, in the mastoid process, or in some of the cervical lymphatic glands if there are any complications. When the earache is accompanied by semilateral or general headache, the case demands earnest attention.

The meatus and external auditory canal must be syringed out with warm water, and cleaned and dried with the cotton holder before inspection. It is often necessary after syringing quite forcibly with a well-elevated fountain or a hard rubber syringe, to wipe the depth of the canal, and the tympanum if exposed, over and over again, in order to remove the adhesive pus, scales, and crusts, and to get a good view of the parts. Then the speculum and otoscope should be used to make a careful diagnosis of the diseased conditions. The skin of the canal will be found more or less congested, reddened, and swollen. When the pus is copious, the macerated and swollen epidermis resembles the skin of parboiled beans, and is adherent in some places and detached in others, hanging in dirty-white shreds to the scarlet rete. The bloodvessels of the rete are dilated, and the connective tissue is infiltrated with serum, lymph cells, and sometimes extravasated blood. These increase the thickness of the soft tissue wall, especially the posterior portion, and diminish the

calibre of the canal, so that in some cases it is exceedingly difficult to perceive the exact condition of the deeper parts. The skin over the bony portion of the canal frequently seems by its velvety surface and free secretion to take on a pathological character, resembling the normal mucous membrane. In very scrofulous patients, the pus is so unhealthy and corrosive, as to destroy the skin upon the floor of the canal, in the sulcus, and upon the lobe of the auricle, so that it is discharged along a channel of raw-edged angry skin.

In rare and ancient cases of purulent inflammation, exostoses of the bony canal are seen, presenting hard, unyielding, rounded elevations into the canal which narrow its lumen. Caries and necrosis of the bone are occasionally found, revealing their presence by swelling, abscess or a sinus of the soft tissues near the seat of the destructive process; and paralysis of the facial nerve occurs from invasion of the Fallopian canal.

Perforation of the *membrana tympani* accompanies purulent inflammation of the tympanum, immediately or remotely following acute inflammation. It may have resulted from ulceration of the edges and enlargement of a paracentesis, during the acute attack; or from a rent, rupture or ulceration, occurring from intra-tympanic pressure during the course of the disease. To find out its nature and extent, after cleansing the canal and membrane thoroughly, inspect the parts with the mirror and speculum.

Note the position and extent of the drum-head, the size and shape of the perforation, the presence or absence of the ossicles, and the movements during a Valsalvian inflation. If the Eustachian tube opens with difficulty, use the catheter and air-bag as before described.

When the tympanum is tolerably dry, there will be a slight whiff or whistle through the opening. Should it contain mucus, the sound will be muffled to a hiss or gurgle, and a little secretion will ooze out and run down the drum-head. The membrane may be seen to move and the secretion to start out in some cases, during the use of Siegle's speculum. When the opening is obscured by pus or it is large and the tympanum contains considerable of it, inflation will cause a bubbling sound, and

globules of air may be seen to bubble through the liquid in rapid succession. In hyperæmia of the tympanum, pus contained therein may pulsate synchronously with the carotid arteries. In rare cases, a polypus may project out of a perforation and obscure it, but it can be moved by a probe, and thus its relation to the parts discovered.

If the pus is ordinary color, it shows tympanic granulations; if it is dark and comes from above or behind, it indicates the presence of caries.

I had one case in which inflation caused a drop of brownish pus to flow from within, over the upper posterior border of the drum-head. A bent probe revealed the presence of caries of the roof of the tympanum and border of the annulus.

Sometimes with perforation there is depression; the membrane is irregular, its outer surface is granular and covered with pus; the malleus handle is absorbed or thickened and invisible, and it is very difficult to discover the membrane at all.

I had a case that I considered purulent otitis, with destruction of the membrane, and adhesion of the manubrium to the promontory. I was surprised to hear a sharp musical whistle during inflation, and, watching more carefully during Valsalva's inflation, I discovered a perforated drum-head, distorted and disguised by adhesions, granulations, adherent pellicles and pus.

The red tumefied appearance of an acute perforation, with its raw and bloody edges, soon passes away; a gray ulceration eats away the borders and enlarges the opening; or the lips of the opening curl a little and become yellowish-gray, thin and fibrous. Later, they may take on a cartilaginous appearance, and receive deposits of carbonate of lime.

The surface of the membrane will look white where elevated, and dark where depressions exist. If the perforation is small, the tympanum cannot be illuminated, and the opening looks dark; if larger, one sees the mucous membrane bright red in the acute stage, deeper red and granular in the chronic condition. The perforation may be very minute, or so large as only to leave a rim of membrane around the wall or a tongue-shaped piece along the manubrium. Sometimes the lower half is gone, and

the upper border is formed by the folds from the short process, extending to the anterior and posterior walls.

The edges of the membrana tympani are often adherent to the walls of the canal and tympanum, and to the ossicles, because the tensor tympani muscle has dragged in the manubrium and favored the malposition.

The manubrium is generally seen as a whitish-gray streak in the membrane, but it may be so obscured by swelling, as to have its position recognized only by a leash of strongly injected vessels. It is frequently dragged inward, upward and backward, touches the inner wall of the tympanum, and is so foreshortened as to be recognized with difficulty. It may adhere to the long process of the incus, and this latter be drawn against the tympanic wall. It is sometimes absorbed, presenting to view only the button of the short process. The malleus and incus are generally absent in large perforations, and the tympanum can be inspected easily.

The promontory is usually paler than other parts of the drum, but the mucous membrane over it may be so swollen, as to lead one to believe a polypus projects from the inner wall. When the malleus is absent, only the long process of the incus, and, perhaps, a branch of the stapes can be seen as yellowish objects upon the red background. When the incus is gone, at the superior posterior third of the inner tympanic wall, behind the promontory, one may see the yellow anterior branch of the stapes, extending from behind horizontally forward and inward, the other arm being hidden above the level of the posterior superior edge of the annulus tympanicus. Brunton's otoscope is necessary to make out the details of this minute anatomy, and one must incline the patient's head towards the opposite shoulder and look towards the roof of the tympanum, in order to see the ossicles when present.

A perforated membrana tympani cannot heal permanently until the mucous membrane is restored nearly to a normal state. The smaller the perforation, the more recent the solution of continuity, and the less the discharge of pus, the greater is the chance of closure; large chronic perforations, with absence of the ossicles, and profound alteration of the mucous membrane are obstinate and can seldom be closed.

When a perforation closes by granulation of its lips, there is not a restoration of the three layers of the normal drum-head, but a formation of true cicatricial tissue. The cicatrix is thin, wrinkled, and depressed, and freely movable by inflation or by the use of Siegle's speculum.

After a perforation has closed properly, rupture of the cicatrix may occur easily from hypersecretion of a persistently morbid mucous membrane, from acute inflammation of the Eustachian tube and tympanum, or from accidental extremes of aerial pressure.

The mucous membrane of the tympanum is in some cases in a state of mild subacute inflammation without granulations, and secretes so little muco-pus that it does not flow out of the canal, but becomes inspissated and forms thin crusts, which block up the tympanum and inner canal, and impede the action of the ossicles and the fragment of membrane that may be present.

In other patients, the mucous membrane is more inflamed, covered with minute granulations, and secretes considerable laudable muco-pus, which flows out of the canal from the movements of the jaw and the individual, but is likely to cling to the irregularities of the tympanum and inner end of the canal, undergo fatty degeneration, unite with the pellicles of exfoliated epithelium, and form masses of a dirty-white cheesy appearance very difficult to dislodge, and, yet, dangerous to let remain.

In other cases, the lining mucous membrane is thickened and hypertrophied, and the membrane of the round and oval windows becomes too stiff to move much. The submucous connective tissue is filled with leucocytes; the blood and lymph vessels are dilated, multiplied and congested, and the epithelial surface is covered with granulations, villous and papillary growths, and rounded or pedunculated polypi. The surface is succulent and hyperæmic and bleeds easily, the secretion is rather profuse, free flowing and fetid, and may be creamy and corrosive or dark, sanious, and offensive.

The intrinsic muscles of the ear sometimes undergo hyperplasia, thickening and shortening, but they generally melt away and are destroyed by ulceration.

Ulceration of the mucous membrane sometimes occurs, and

caries of the ossicles and various portions of the tympanic wall, especially the roof, may supervene in consequence.

The chorda tympani nerve is irritated or destroyed, and the Fallopian canal is occasionally invaded by the inflammatory process, resulting in paralysis of the facial nerve.

Exostoses arise beneath the diseased membrane from the co-existing periostitis and osteitis, and may fill a great part of the tympanum. The dura mater over the ear is frequently thickened by the contiguous disease, abnormally adherent or loosened from the roof, and may be covered with particles of pus.

The inflammation and morbid products may extend into the mastoid cells and cause mastoid disease; and into the Eustachian tube and the pus flow into the pharynx, but this is uncommon.

Croupous and diphtheritic membranes have been formed rarely over the tympanum, and tuberculous and calcific deposits are sometimes seen in mucous membranes affected by purulent disease.

The whole temporal bone around the ear is more or less congested and its periosteum hyperæmic, so that the morbid process can easily reach the bloodvessels or the brain and destroy life.

Dr. Roosa says, "The cavity of the tympanum is covered above by a thin, rarefied bony plate, which is in direct communication with the cerebral meninges; the floor is close to the great jugular. Its internal wall is the labyrinth wall, with its two fenestræ, covered only by thin membrane and opening into the ramifications of the acoustic nerve and the fluid which is continuous with that of the sub-arachnoid space; while externally we have a membrane of about the thickness of letter-paper."*

To contemplate such serious disease in this region as I have described causes anxiety; to see the destructive processes going on day by day in a confiding patient, ignorant of the danger, awakens the gravest apprehension.

The prognosis will depend upon the constitution of the patient and the condition of the ear, as revealed by a careful inspection of the tympanum after it has been thoroughly cleaned, and the following statements are proved clinically:

* A Practical Treatise on Diseases of the Ear. Roosa, p. 372.

When the tuning-fork is heard well, vibrating upon the vertex, the perforation is small, considerable membrane remains attached to the manubrium, and the mucous membrane is merely inflamed and not degenerated, the chances of healing the drum-head and improving the hearing may be considered favorable.

When cranial perception of the fork is good, the perforation is quite large and impossible to close, the ossicles are partially or entirely gone, but the mucous lining is in a state of subacute inflammation without much granulation, the discharge may be arrested, and the range of hearing increased to a moderate degree; the latter can be slightly augmented by wearing a cotton drum-head or Toynbee's artificial membrana tympani.

When the purulent inflammation has existed months or years; the perforation is large; the ossicles are absent, displaced or ankylosed; the mucous membrane is profoundly diseased; large granulations or polypi are present; the pus is illaudable and corrosive of soft parts, perhaps, containing small particles of bone; the constitution is strumous and feeble, and the vibrating fork upon the vertex is not well heard, a guarded, and generally an unfavorable prognosis as to hearing and, even, to life itself should be given, and treatment energetically advised.

The existence of polypi within the tympanum, paralysis of the facial nerve, caries and necrosis of the temporal bone, and mastoid disease, are grave and threatening complications of purulent inflammation. The aural surgeon knows from experience how suddenly death may come in some of these cases, and will be on his guard in prognosis, whether the patient is neglected or treated in a thoroughly scientific manner.

I shall consider here the measures to be adopted for ordinary cases, and mention complications of the disease under separate divisions.

Treatment.—The treatment of chronic purulent inflammation of the tympanum is local, surgical, and medical. Of the three, the local is the most important, though the surgical may in some cases be of equal value.

Washing out a chronic suppurating ear properly seems such a simple thing that every one thinks he can do it easily. There never was a greater mistake. It is difficult for the aural surgeon

himself, and it may be safely stated, that no uninstructed person can do it *secundum artem*. I would refer the reader to what I have written elsewhere upon this subject, and here emphasize some points of importance.

The sensibility is so great in some of these cases, that the syringing must be very gentle. The jet of the fountain syringe can be so easily tempered to the feelings by raising or lowering the bag, that it should be preferred for very sensitive cases. The divided jet is then, also, preferable to the single one, as it breaks the force of the water. After a few visits the hand syringe can be used even forcibly.

Distressing vertigo is sometimes caused by syringing. I have had several patients, who were obliged to lie down immediately to prevent fainting, and two fell insensible out of the chair from forcibly injecting water into the ear with the universal syringe. This idiosyncrasy usually disappears, as the pain does, after a few treatments, though it may always be a distressing accompaniment. In such dilemmas, have the patient recline during the douche with the fountain, diminish its force to the minimum, and increase it gradually as it can be borne.

When the divided jet cannot be tolerated at all, let the patient recline in an easy chair, fill the diseased ear, which should be uppermost, with warm water, and swab it out with the cottoned holder. If this does not cleanse the ear, fill it with a solution of bicarbonate of sodium (*Sodii bicarb.* gr. xx, *Aqua* f3j), leave it in for five or ten minutes, then wipe and dry the parts with absorbent cotton until every particle of mucus, pus, scab and scale is removed. Only then, should medicinal agents be applied locally. Of course, if the hole in the drum-head is small, wiping out the tympanum will be out of the question. The tympanum can occasionally be cleansed by injecting through the catheter in position in the Eustachian tube. This is a preferable method in vertiginous cases, but is inapplicable to children. The head should be inclined towards the affected side, the catheter introduced, the syringe fitted closely into its end, and the fluid forced slowly and steadily through and caught in a bowl held below the ear. Some writers are enthusiastic over this method, but in a

large majority of cases the fluid will not pass, but go down the throat.

If the suppuration cannot be arrested by the usual treatment, the perforation of the membrane must be enlarged, so that the tympanum can be more thoroughly treated. The enlargement of the perforation and free liberation of the discharge usually increases the hearing considerably. Sometimes the discharge ceases to flow outwards, considerable pain is felt in the ear and side of the head, and there is some feverish disturbance, owing to caking of the matter at the inner end of the canal, and closure of its lumen. The obstruction must be immediately removed. The pressure of pus behind such an obstruction causes epileptoid attacks in patients quite frequently.

There are cases of chronic purulent otitis that should not be syringed at all. They are in the first division as above, where the drum-head has a moderate sized perforation, the discharge is slight, and it inspissates and forms a few yellowish-brown crusts in the canal or upon the membrane.

Remove these by fine hooks, a camel-hair brush wet with glycerine, and the cottoned holder dry or moistened with water. One can, under good illumination by head-mirror and speculum, get the surfaces clean enough for the reception of the mild remedies indicated.

In another variety or stage of the disease, where the perforation of the tympanum is of medium size, and the tympanum is merely moist and glistening, or the mucous membrane is covered by a thin coating of creamy laudable pus, though not enough is secreted to run outwards, it is best to be conservative. Cleanse the tympanic mucous membrane with absorbent cotton on the holder, and apply only the mildest remedies.

When in either of these states, scabs form upon the membrane around the perforation, perhaps, over it, in an attempt to close and heal it, and thus protect the tympanum from exposure to the atmosphere, one should favor the process, and be chary of douches and instillations.

In the other divisions of this disease, and in its complications, a douche of a pint of warm water should be injected in the ear once or twice a day according to necessity, and then the proper

wash be dropped in after drying. This will generally be sufficient treatment at home, and the aurist ought to see the patient every other day or every third day at the longest, when he should cleanse the ear thoroughly by douche and cottoned holder, and make the appropriate antiseptic, astringent or caustic application.

When the ear and its secretions smell badly, I add Tar tincture or Phenol Sodique, f3ij to a douche of a pint of warm water, as an antiseptic stimulant. Either of these cleanses and improves the condition of the diseased mucous membrane. After the douche, it is necessary to dry out the ear with the towel, remove every particle of matter with cotton, and apply the local medication.

Alum, sulphate of zinc, sulphate of copper, acetate of lead, nitrate of lead, subsulphate of iron, nitrate of silver, permanganate of potassium, iodoform, salicylic acid, salicylate of sodium, chlorine water, spirits of turpentine, glycerine, acetic acid, boracic acid, chromic acid, tannic acid, tincture of iodine, carbolic acid, chloro-acetic acid, and nitric acid are the most prominent agents employed in the local treatment of purulent inflammation of the ear.

There is too much routine work in the use of them in everybody's practice, and a reform in this direction is greatly needed.

The selection of the most suitable topical remedy for a given case is not easy, because of the absence of exact observations of diseased conditions, and the effects which individual substances have upon them.

Local applications are made to a suppurating tympanum to astringe relaxed tissue, to destroy morbid and undervitalized growths, to diminish the discharge, to stimulate to healthy action, to have an antiseptic influence, and, through most or all of these effects, to favor and hasten the curative process.

The agents that have proved most efficient in bringing about these results have been enumerated above, and I shall now try to indicate as well as I can from the data at my disposal, the guiding principles of selection.

It is the prevailing opinion of aural surgeons, that the vegetable astringents are far inferior to the mineral, in suppuration of the tympanum, and the latter will be first considered.

Cullen said, "astringents produce contraction and condensation of the soft solids, and thereby increase their density and cohesion." Boerhaave said, "they cause the parietes of the blood-vessels to approach one another, close these tubes when open, increase the strength and rigidity of the fibres, and restore firmness to relaxed tissues."

When the atonic condition of the mucous membrane of the middle ear in chronic suppuration is reviewed, it is evident that the effects of astringents described in these two masterly definitions are just the ones desirable to bring about in the morbid tissues; and, that, inducing these, such a train of salutary consequences will follow, that the patient will be put upon the high road to recovery.

An astringent then is often a *sine quâ non*, but which one of the many offered is the *questio vexata*. There are some other local agents beside astringents that are of use.

Answers to some of the queries of aural practice may be found below, and it is to be hoped, that close observation will soon increase the data which I present.

Alumen is slightly antiseptic, astringent, stimulant, irritant, styptic or caustic, according as it is used. It is not so sharp in its action as zinc, but is more active than lead. It is considered antispasmodic, and might prove useful, when the tensor tympani muscle acts irregularly. In hemorrhage, a saturated solution or the crude powder quickly arrests an ordinary flow of blood, as it is a strong styptic. The *alumen exsiccatum*, or dried burnt alum, is a mild manageable caustic, and quickly destroys granulations in the tympanum. It should be blown upon the diseased surface by an insufflator. A piece of rubber tubing with a mouthpiece at one end and a cut goose quill, a hard rubber or glass tube at the other is very handy; a large Eustachian catheter will answer the purpose very well; but the powder-blower figured elsewhere is the best instrument for the purpose.

This remedy is suitable in case of large perforations in the membrane; exuberant flabby granulations in the tympanum; a pale condition of the mucous membrane with, perhaps, ulcera-

tion; absence of hyperæmia and pain; a copious discharge of fetid muco-pus, and a general atonic state of the parts.

If there is evidence of considerable irritation, alum should not be used, as it excites inflammation readily, and is said to cause furuncles in the cartilaginous portion of the auditory canal. If decided action is desired, a grain or two of the crude powder may be blown into the tympanum twice or three times a week, or a saturated solution can be instilled once a day. Between visits and for general use at home, a solution of five to ten grains of the salt to a fluid ounce of water should be used morning and evening after carefully cleansing the ear.

Boracic Acid.—This acid is prepared from borax, a biborate of sodium, by treating a hot solution with sulphuric acid. The product is various sized white crystals, which have the feel of soapstone. They should be powdered for use in the crude state, but this is not necessary for solutions.

The fashion of the hour is to ascribe nearly every disease to the generation and multiplication of bacteria, and, as boracic acid has the property of a bacteriacide, the profession has become extravagant in its use and praises, just as it was ten years ago about carbolic acid. I am not a believer in the parasitic origin of constitutional diseases, and, therefore, scrutinize the action of so-called parasiticide remedies with unbiased judgment.

Boracic acid is detergent, antiphlogistic, and antiseptic, and is largely used in a crude state in purulent inflammation of the middle ear. It is applied to the cleaned diseased mucous membrane by the powder-blower, and it is customary to fill the whole tympanum with it. The meatus should be closed with cotton and the ear remain in *statu quo* until there is evidence of the presence of purulent products, when the parts must be cleaned thoroughly again, and the powder be reapplied. The acid is, also, used in a solution of from ten grains to saturation, as a detergent antiseptic wash of considerable value.

The crude powder is indicated when the mucous membrane is smooth, reddened, and secretes a moderate quantity of badly smelling pus. The membrane is not granular or relaxed, but seems much congested and threatening periostitis. The temper-

ature of the cavity will be found above blood heat, the sensitiveness increased, and pain frequent, especially at night.

The condition closely approximates that requiring nitrate of silver. There is not so much pain on contact as with the silver, and the mucous membrane is smoother.

Solutions of the acid are valuable for cleansing and antiseptic purposes, before the use of other more active agents, in purulent inflammation of the tympanum, mastoid disease, and caries of the temporal bone. The weak solutions are beneficial and even curative for mild degrees of mucous inflammation, but both solutions and the crude powder have proved secondary to other remedies in my practice.

Sulphate of Zinc is astringent, irritant and styptic. It is more active than alum, and suitable for purulent inflammation of the ear in weak constitutions; when there is an atonic condition of the middle ear; the mucous membrane is pale, covered by pale, easily bleeding granulations and, perhaps, one or two polypi; it shows a spot or two of indolent ulceration, and considerable muco-purulent discharge. The remedy should be used in solutions of two to five grains to a fluid ounce of water, instilled in the ear once or twice daily.

Sulphate of Copper, crude, is a mild caustic, but is rarely used as such in the ear. In solution, it is considered an astringent tonic to the mucous membrane, rather more irritant than zinc sulphate. It has decided antispasmodic qualities, which make it applicable to suppurations of the ear, accompanied by spasmodic action of the tympanic, throat or facial muscles. It is suitable for the atonic, granular and ulcerated phases described under zinc, especially, when there is caries or necrosis of the temporal bone.

It is used in solutions of two to five grains to the fluid ounce of water, once or twice a day, and must be washed off the meatus by simple water as it is apt to discolor the skin somewhat.

It may be employed as an intercurrent application with great advantage, where other remedies seem to have little effect. After its use, the canal is sometimes of a bluish tinge.

Acetate of Lead is a mild astringent of considerable value in some cases. It is sedative and cooling, and just the thing for

chronic purulent otitis with considerable heat, hyperæmia, and frequent pains. It is especially useful during acute exacerbations, and may be used at any stage of inflammation with benefit.

Nitrate of Lead is preferable for cases with ulceration and very offensive discharge, as it unites with the sulphur of sulphuretted hydrogen, decomposes the gas, and deodorizes the muco-pus.

Both these salts are employed in solutions of from two to ten grains to the fluid ounce of water, twice a day, but should not be long continued, as the lead is prone to unite with the albumen of the tissues and form an irremediable crusting, as when applied to solutions of continuity in the cornea. After an instillation, the tympanum looks white, but it soon becomes darker from the formation of lead sulphide.

Solution of Subsulphate of Iron is an aqueous solution of the iron, employed occasionally as an astringent, styptic and cauterant. In a pure state, it is second only to Monsell's salt as a hæmostatic in hemorrhage. It stimulates and tones up an old suppurating mucous surface, and destroys granulations and polypi in a remarkable manner.

In strumous patients, having flabby granulations and the softer polypi in the tympanum, the remedy in full strength should be instilled or applied upon cotton to the growths once a day. A few applications will frequently cause them to shrink up and disappear, the mucous membrane of the ear to become smoother and healthier, and thus favor the curative process. Active hyperæmia contra-indicates its use, as it is somewhat irritant, but dark passive congestion is a symptom demanding it. After its application the tympanum looks greenish-brown or black. Its use must be watched, as it is likely to form iron crusts and masses of coagulated pus and fibrin.

Nitrate of Silver is styptic, but is rarely used for that quality. It is astringent, stimulant, alterative, antiseptic, antiphlogistic and caustic, according as it is employed. The remedy should never be used in the ear in its crude state, but in solutions of various strengths. It causes little pain, acts quite superficially, as it is decomposed by the tissues with which it comes in contact, and may be used with advantage and safety in any stage of inflammation. It has a particular affinity for morbid tissue, which

it destroys, leaving the healthier tissues around and beneath. These are stimulated, cleansed, and altered to a better state of nutrition by the action of the silver salt, speedily take on a healthier action, and repair any damage to their continuity.

A profuse muco-purulent discharge from the tympanic mucous membrane, with or without ulceration; the presence of granulations or small polypi; a condition of hyperæmia, with occasional pain, threatening acute exacerbation; a great deal of painful sensibility on contact, and, especially, cases that do not improve under other applications, require nitrate of silver.

There are aurists, who use this remedy for any and every case of purulent inflammation of the tympanum; but as some other medicines already mentioned cure easily, and this is liable to stain the auricle of the patient and the hands of the operator, it should only be resorted to, when its special symptoms are present or other agents fail.

The fused stick nitrate is impure, and the crystals should be employed, dissolved for obvious reasons in pure distilled water.

In ordinary cases, a solution of five to ten grains of the salt to a fluid ounce of water is sufficiently strong, but when the disease has existed a long time, and the tissues are profoundly altered, twenty to forty grains to the ounce or a saturated solution may be necessary. Very favorable reports of the action of the stronger solutions have been made by reliable physicians. There is danger of paralysis of the facial nerve with these strong solutions when caries exists, and they should then be used cautiously upon cotton or not at all.

The application should not be intrusted to the patient or his friends, but be made by the physician himself, every day for the mild solutions, and every second or third day for the stronger ones.

After cleansing thoroughly, the solution should be put in the ear with a dropper, and neutralized in a few minutes by a syringe stream of mild salt (*sodium chloridum*) and water, so that the auricle will not become stained.

This need not be thrown into the tympanum, but played upon the meatus, so as to unite with the silver solution, as the head is inclined and it flows into a bowl or other receptacle. Unless

this is done, the sulcus and lobe of the auricle will be stained brown in a few hours, and the patient will be justly indignant, especially if a lady.

At the time of application, the patient will experience a warm smarting sensation in the ear, and if the Eustachian tube is pervious, may have an acrid taste from leakage into the pharynx. I have had a patient immediately drop the head forward and blow a drop or two from the nose, getting thereby a disagreeable olfactory sensation and a stained handkerchief.

If the tympanum be examined after instillation of the remedy, it will show a white coat of the chloride or albuminate of silver. This turns brown and then black in a few hours from the formation of oxide of silver, and must not be mistaken for carious products, or an accumulation of cerumen.

Permanganate of Potassium is a remedy of much value in chronic suppuration of the ear. It dissolves purulent masses, deodorizes and disinfects fetid discharges, cleanses and soothes the mucous membrane, stimulates ulcerated surfaces and favors and hastens a cure. It is equally applicable to catarrh of the nose and pharynx, and is excellent in ozæna.

In ordinary cases of suppuration in the tympanum, a solution of ten to twenty grains to the fluid ounce of water is required, once or twice daily. A tendency of the discharge to form gelatinous lumps and stringy adhesive masses, and the presence of a foul odor call for this salt once or twice a day.

Iodoform has won a deserved reputation for ill-conditioned ulcers in other parts of the body, and is somewhat beneficial in the disease under consideration. It is non-irritant, anæsthetic, anodyne, alterative and disinfecting, and may be tried in obstinate cases, where other agents have failed.

The symptoms demanding it are, pale mucous membrane with granulations; weak, indolent gray ulceration; a fetid discharge or light-colored pus, and a scrofulous constitution. The crude powder or a mixture of equal parts of iodoform and tannic acid may be blown upon the diseased surface once a day, and permitted to remain until the next syringing.

Tannic Acid is a vegetable astringent, sometimes recommended for suppurating ears. It is irritating, bulky, dirty, and, some

say, nearly inert for purulent cases. It might be used as an inter-current remedy, in obstinate cases, in solutions of ten to twenty grains to a fluid ounce of water. In powder or saturated solution, it is an excellent styptic, preferable to iron to arrest hemorrhage after polypus extraction, caries of the temporal bone, and other lesions.

Hamamelis and *Hydrastis* owe their astringent virtues to the tannic acid they contain; they are inferior to the pure substance, and I would not recommend them for local applications.

Alcohol is antiseptic, astringent and stimulating, and exercises a curative influence upon flabby granulations and ulcerative processes. It whitens the granulations, constricts the tissues and vessels, coagulates the blood, and interrupts the morbid process.

Granulations and mucous polypi soon shrink and disappear under its application, and fibrous growths, though more obstinate, are frequently destroyed. Several weeks or months will be necessary to restore the mucous membrane to a healthy condition and to effect a cure. It is applied diluted and even pure.

Iodine is sometimes useful in a granular, inactive state of the tympanic membrane, accompanied by swollen lymphatic glands, and a strumous constitution. I use a solution, containing iodine twenty grains, iodide of potassium twenty grains, and glycerine forty grains. This is caustic, and should be applied to granulations by a camel-hair brush or a cottoned holder, and washed away in five minutes by a syringe of water. Add an equal quantity of water to this formula, and the fluid will be suitable for instillation, and stimulation of the mucous lining of the tympanum, Eustachian tube, and throat. Iodine solution should be used cautiously in the tympanum, as the vapor is very penetrating and stimulating and may excite acute exacerbations.

I sometimes spray the middle ear with twenty drops of the undiluted mixture to a fluid ounce of water, and think I have seen benefit from its use. Every other day is often enough to make use of any of these iodine solutions.

Spirits of Turpentine is a representative of the balsams, and like all of them has an antiseptic, stimulating, and sanitary influence upon the mucous membranes. Ten to twenty minims in a fluid ounce of water, instilled into a cleansed but chronically suppu-

rating tympanum, with bluish venous congestion, will destroy the fetor, diminish the purulent discharge, and stimulate the surfaces to healthier action. Fernel wrote, "*Terebinthina calefacit, mollit, discutit, tergit, expurgat; obstructiones tollit, et angustos meatus aperit.*"

Salicylic acid, salicylate of sodium, chlorine-water, glycerine and many other remedies are praised for their virtues in purulent otitis, but their qualities are known by all physicians, their value is secondary to the agents already enumerated, and I shall not consider them further in this connection.

The tympanum and auditory canal having been cleansed by injections and absorbent cotton upon the holder, and the Eustachian tube cleared by a strong inflation, the remedies I have just mentioned may be introduced, if fluid by the syringe, a teaspoon or a dropper.

Tuck a towel close around the neck of the patient, over the shoulder of the side that is being treated, incline the patient's head towards the opposite shoulder and put in the solution. Let the patient keep quiet and retain the remedy for five minutes at least, and practice Valsalva's inflation once or twice to favor the passage of the fluid into and through the Eustachian tube. If the patient cannot open the tube, use the air-bag without or with the catheter.

Then at the expiration of the time, place a cup under the affected ear, bend the patient's head towards it, catch the outward flow, and dry the meatus, auricle and neck with the towel.

When one uses nitrate of silver, the neutralizing salt solution is to be thrown upon the lower wall of the meatus, as the patient alters the position of the head, and a warm douche ought to be used afterwards to remove the white coagulum of chloride of silver. This treatment, except that with nitrate of silver and the air-bag, should be taught to the patient's assistant or nurse, and be followed closely at home. Inflation by Valsalva's method should be insisted upon every time the instillation of the astringent is made, as it cleanses the Eustachian tube, drives the pus outwards, and permits the medicine to reach the disease more thoroughly.

One or two dressings daily will accomplish all the good of half a dozen, because reaction in the tissues must be established between times. The use of powders has been described under alumen, *et seq.* The syringing, cleansing, and medication must diminish *pari passu* with the disease, until one treatment a day, one in two days, and finally dropping in the medicine alone every other day will be sufficient.

Another method of treatment has come into favor of late for those cases, which can visit the aurist once or twice a day. It may be called the dry treatment; and consists in cleansing the ear thoroughly with tuft after tuft of absorbent cotton, and the application of medicated cotton, or the usual medicated solutions or powders afterwards.

This makes much work for the physician and larger fees, but in my opinion has no advantage over the wet method. It is very difficult, not to say impossible, to clean a suppurating ear thoroughly with cotton pledgets, and few patients can endure the necessarily close wiping of the hypersensitive tympanum. I have tried the innovation and abandoned it, except in peculiar cases, as of doubtful utility, and throw the burden of proof of its superiority upon its enthusiastic votaries.

There is no proof that moderate syringing of a suppurating ear to get rid of the pus and débris increases the disease one iota; on the contrary, long experience approves this method of cleansing, and it is certainly less irritating to the mucous membrane than dry wiping. Probably the rigidly dry method will in the future be mentioned as a curiosity, as are now the aural douches of a pailful of water at a time, recommended by Itard.

When the secretion of the tympanic mucous lining has been restored to nearly a normal condition, efforts must be made to close the perforation, as detailed under injuries of the membrana tympani; or failing in this, an artificial drum-head may be adjusted to the peripheric remains of the membrane, or to the inner end of the canal, as directed under artificial membrana tympani, to which the reader is referred.

When suppuration has been arrested, the ear will present one of the three following conditions:

1. The membrane may be closed by a cicatrix, and the mucous membrane of the tympanum be healthy.

2. The membrane may show a small or medium perforation, and the mucous membrane be a little hyperæmic and moister than usual.

3. There may be a large perforation, and the mucous membrane look pale, thick, and dry from an extension of the epidermis of the canal into the tympanum, so that the lining is very much like the skin. This dermic transformation is considerable protection against future attacks of suppurative inflammation, and lately attempts have been made to induce this change by placing grafts of skin upon the granular mucous membrane.

There are several acids employed for cauterizing purposes, which may as well be mentioned in this place. They are acetic, chromic, carbolic, chloro-acetic and nitric acids.

Acetic Acid is cooling, astringent, stimulating, and caustic; it has a destructive action upon morbid tissues, and an affinity for the cellular structures of malignant growths. It does not cause much pain, but is not used as much as formerly.

Nitric Acid is a severe caustic, causing deep, persistent ulceration and severe pain. It destroys granulations and polypi rapidly, is thought to exercise a tonic influence upon surrounding tissues, but must be used sparingly, and should always be neutralized by a solution of the hydrate or carbonate of potassium.

Chloro-acetic Acid has all the virtues of acetic acid, is rather more antiseptic, and causes only slight and transient pain, quickly removed by an injection of warm water. It is a favorite agent for the destruction of granulations and soft polypi in the ear.

Carbolic Acid has not been employed in tympanic suppuration as much as its merit demands. It is stimulating, strongly antiseptic and disinfectant, causes local anæsthesia, and is, in my opinion, the very best of this group of remedies for cauterizing fungous granulations and soft polypi. I use the pure deliquesced crystals on cotton for this purpose, inject warm water afterwards, and dry out the ear carefully.

It should have the preference in all cases accompanied by a foul odor, and by caries or necrosis, and may be employed with

advantage as a daily cleansing injection, in the proportion of five minims to a fluid ounce of water. The pure acid is, also, an agreeable, manageable, efficient agent with which to irritate or blister the surface of the mastoid process, if an exigency should arise to demand this procedure.

Chromic Acid is a more powerful escharotic than any of those mentioned. It is slow, deep, and persistent in action, and justly has the preference for the destruction of dense, fibroid polypi, or their roots remaining after abscission. A few crystals and a few drops of water, or about one part of the acid to four of water, give a suitable solution for cauterization. The morbid growths alone should receive the caustic; the action must be watched and the acid neutralized by a hydrate of potassium or carbonate of sodium solution, when it has gone far enough. Burnett says, "Under no other application does the remnant of the pedicle of a polypus disappear so surely and so rapidly."

The method of applying these powerful remedies is to twist a small tuft of absorbent cotton upon the end of a roughened silver probe, and make a miniature brush; the brush part should be about four millimeters in length and diameter. Dip this into the acid and press the surplus out upon the neck of the bottle, or upon a tiny dish, then under good illumination with the head mirror and rubber speculum, touch the diseased place firmly and remove the probe. This should be done twice or three times a week for granulations, but in case of polypi or their remains, the operation should be performed every day. Between times, a pledget of cotton should be kept in the meatus to catch the drain, and a simple warm douche employed to remove pus and débris.

When the caustic is no longer necessary, the astringent stimulants should be commenced and continued till a cure results. Tissues get accustomed to a remedy after prolonged use, and it is well to change to another and another, till the proper one cures. The state of the tissues will be a guide to the selection. The touching and medication should be diminished gradually as the disease disappears.

The presence of granulations of moderate size upon the mucous membrane of the diseased tympanum is not a complication of the

disease, but an ordinary concomitant, and will not be given a special division. These granulations vary in density and size, and predispose to the formation of polypi by increasing the quantity of discharge.

They may be so solid, that wiping them with a hard cottoned probe will merely redden them; or so soft, succulent, and vascular, that they will bleed freely from mere touching. The former will require the stronger applications and the latter the weaker. Sometimes one application will destroy them, but generally considerable treatment with both a caustic application and an astringent wash will be necessary. The clearer the tympanum is kept of pus the sooner they will vanish.

I have insisted upon inflation before and during the dressings of the ear by the physician and by the patient, in order to drive all of the pus out of the Eustachian tube and tympanum, and to permit the flow of the medicated solution into the tube and pharynx. This happens in a majority of the cases, though the flow of pus through to the throat is rare. When the air passes through the tube with difficulty, or not at all, the medicine ought to reach the tubal lining.

To effect this, clean the tympanum, introduce a rubber stopper closely into the meatus, having a perforation in the centre for the nozzle of the hand syringe; fill the syringe with salt water, press it tightly into the perforation, incline the head forwards, and with firm pressure send the piston home. The water may spray all over the patient and the operator unless he is careful, but it may go through the tube to the throat and drop or flow from the nose. Then use a little of the medicated solution in the same way, but do not try nitrate of silver for obvious reasons, unless the tube is very free, when it should be dropped into the canal inside the stopper, and forced through by a plain water injection.

Another method of cleaning and medicating the tubal mucous membrane is by injecting through a Eustachian catheter *in situ*, but though apparently easy, this is really difficult, and not so comfortable for the patient, who swallows the leakage from the inner end of the catheter. Both methods should be employed when the tube is obstructed, and both ends thus medicated.

Most of the medicated solutions may be used for the Eusta-

chian tube, that are recommended for the tympanum. In some cases, I have been able to force fluid from the tympanum through the tube, and unable to reverse the process through the catheter, though the position of the latter in the tube was verified by the usual tests, and an inspection of its inner end by means of a throat mirror. It is probable that a relaxed mucous membrane closed the tube, or the force of injecting into the catheter pressed its inner end too hard against the side of the tube.

The local measures outlined above should be continued persistently by the physician, assisted by the patient and attendant, no matter what the seeming discouragement.

It will be difficult to get the home treatment done systematically, and the physician must be vigilant in finding out how his orders are executed, and insist upon thorough work.

A careful diagnosis of the morbid state, good judgment in reference to the selection of the local applications, and the intelligent co-operation of the patient will do wonders in purulent otitis. The hygiene of the patient and internal medication must not be neglected.

The surgical treatment in a given case will depend upon the complications. Affections of the auditory canal and tympanic membrane have been already discussed. Operative proceedings for polypi, exostoses, caries, necrosis and mastoid disease will be considered in a separate chapter, under complications of purulent inflammation of the tympanum.

The hygienic and medical treatment must now engage the attention. The patient ought to live in a dry non-malarial region, have good nutritious food, and clothing appropriate to the season. Home, river, and sea baths may be taken in moderation, but reaction must be established by wiping the body dry and red; the hair should be kept as dry as possible, and the ears should be closed temporarily by bits of cotton. This may prevent hearing 'what the wild waves are saying,' but it will prevent earache. Water in the ear is likely to increase the irritation, especially sea-water, and exposure may give the most careful bather a coryza or sore throat, which may aggravate the tympanic disease. Baths are quite beneficial to the general health, but should be indulged in with caution, especially, if the patient

is anæmic and possessed of little reactive power. Warm brine baths are more suitable to this class of patients.

Scrofulous persons, well rounded by fat and muscle, and having good appetite and digestion, improve their aural affections by a short summer visit to the sea-shore ; but the pale, thin, weakling finds the water too cold, the winds too strong, the dampness too great, and very often comes home with health unimproved, and the ear disease, if not worse, at least no better. This latter class do best in the dry, rarefied atmosphere of the mountains, where balsamic airs and deep fragrant woods soothe the nervous system, and stimulate the mucous membranes to healthy activity.

Cresson Springs, Pa., is a very salubrious place for these patients, but the chalybeate water should be taken, if at all, only in small doses. The calcic sulphur water of the Yellow Sulphur Springs, the iron and alum water of Rockbridge Alum Springs, Va., and the sulphur water of Bedford, Pa., are appropriate for strumous ear cases.

Syphilitic, rheumatic, and gouty patients often derive much benefit from short visits to some of the numerous springs with which our country is favored. It is fashionable and proper to take a vacation in the summer, and those patients who can get away should not wander aimlessly about, but by physician's direction seek the place most favorable to their cure.

The Hot Springs of Arkansas have a deserved reputation in syphilitic cachexia, which must be removed and the blood purified before a permanent cure of specific aural disease can be expected.

The rheumatic and gouty diatheses are favorably modified by the waters of Bedford Spring proper, of the Congress and Geyser, at Saratoga, N. Y., and of Saint Catherine's Wells, Canada ; and the pleasures of a two weeks sojourn at any of these charming places will do more than the waters to invigorate a jaded and depressed vitality, and thus promote healthier action in a diseased mucous membrane.

Most of these mineral waters can be procured on draught or bottled at the pharmacies, so that they may be employed, if thought desirable, without going away from home.

The medicines of value in purulent inflammation of the ear

are few, and I shall not devote much space to their consideration. In acute exacerbations, Aconite, Belladonna, Chamomilla, Pulsatilla, and others mentioned under acute inflammation of the tympanum, should be reviewed, and douches, gargles and inflations made as usual, until active symptoms subside. The canal and tympanum are to be cleaned out thoroughly, as obstruction to the outward flow of pus is oftener the cause of pain, than acute inflammation.

Most of the mild cases mentioned under number one and two, in my division at the beginning of this article, may require Arsenicum, China, Hepar, Kali bichrom., Kali hydriod., Mercurius, Rhus or Silicea. Some few of number two, with those of number three and varieties, are best treated by Aurum, Calc. phos., Calc. carb., Calc. iod., Ferrum iod. and Terebinthina. This is a general statement, subject to many exceptions, as will be seen from the symptoms under individual medicines.

Arsenicum Album is indicated, when there is anæmia, localized oedema, weakness, and renal irritation from erythematous disease. Persons of robust health, except in the ear, having a tendency to vesicular, pustular or phlegmonous eruptions, especially, in and about the ear, are greatly benefited by the remedy. I have not been satisfied with its action in those cases of intense struma, where the drum-head and ossicles melt away in the profuse suppuration.

When the throat is rough, dry and granular, there is burning and soreness during swallowing, the expectoration is slight and viscid, inflation is easily, almost noiselessly accomplished, and the cervical glands are a little hardened by infiltration, Arsenic is very useful.

The special ear symptoms calling for it are: purulent inflammation of the tympanum of moderate degree; the pus is ichorous and irritates parts with which it comes in contact; the canal is rough and scaly; the mucous membrane is red, shining and dry in places, has small dense granulations or polypi not inclined to bleed; there is much sensitiveness to contact, and a tendency to hypertrophic processes in the mucous membrane, fibrous tissue, and intrinsic muscles.

Aurum.—The pathogenesis of gold is remarkably diluted, and reliable indications for its administration scarce. It was long ago recommended highly for scrofulous and syphilitic diseases, but abandoned because other medicines were superior to it. The patient requiring it is peevish, depressed and melancholy; feels weary and worn; is over-sensitive to touch and motion; the bones ache and the joints are sore and stiff; the skin may show some slight eruption, or the subcutaneous tissue of the lower limbs be œdematous. The digestive and urinary tracts are irritated and disordered; the urine and insensible perspiration are increased; the heart's action is augmented and disturbed, and fitful feverish symptoms may ensue.

The eyes are sometimes in a condition of chronic conjunctivitis, neuralgia shoots about the face, the orbital and cranial bones are sore to the touch, and may be affected by caries or nodes.

There may be coryza, sneezing, and mucous discharge; chronic nasal catarrh with an excessively fetid and offensive discharge of crusts and pus; ulceration, pain and closure of the nose; caries of the nasal bones, tenderness of the nose and forehead, with severe headache between and over the eyes.

The throat is rough and granular, the tonsils are swollen and hypertrophied, swallowing may cause pain, and the palatine bones be carious.

The cervical glands below the ear are enlarged; offensive, yellowish-white pus flows from the auditory canal; the membrana tympani is largely perforated; the ossicles have mostly disappeared; a polypus may fill the middle ear; the tympanic membrane is generally pale and flabby, and may show to the probe one or two sinuses, or there may be exostoses beneath it.

Caries of the roof and posterior external portion of the tympanic wall, extending to the mastoid, with a sinus discharging dark pus behind the ear, is a common condition. The pus of caries, whether from the sinus or from the meatus, is generally of mahogany color, owing to the admixture of blood and little particles of dead bone. It is not infrequent to have a light pus from the meatus, and a dark pus from the mastoid sinus, or *vice versa*; the foul odor of the darker is almost pathognomonic of necrosis and grave disease. There is generally some tension and pain in

the mastoid and around the auditory canal; the overlying tissues are red, boggy and œdematous from inflammation, and there is great sensitiveness to cold.

Such are the leading symptoms accredited to Aurum. Let them not lead away from other medicines, that have been better proved and have rarely disappointed.

Cinchona is sometimes required in purulent otitis. It is demanded by torpor of the vegetative functions, confusion of the mind, debility, great sensibility to cold, and fitful feverish symptoms; by rough sore throat, pain on swallowing, swollen sub-maxillary glands, and heat and sensitiveness in the aural region.

The ear symptoms demanding *Cinchona* are, intermissions in the severity of the symptoms; ringing, roaring or rumbling tinnitus; a stopped, full feeling in the ear; neuralgic paroxysms in the ear, side of the head, and occiput; a moderate suppuration of the tympanum, the pus sometimes mixed with blood; considerable bright redness and heat of the auditory canal; a smooth crimson inflammation of the mucous membrane, without granulations or polypi, but with excessive sensibility to touch.

Occasionally the discharge diminishes, the patient has a light chill followed by red cheeks and slight fever, which disappears when the discharge becomes free again. As an intercurrent remedy in hectic, caused by caries of the temporal bone, this medicine has no rival.

Calcareæ Phosphorica is a nutritive stimulant, which exercises marked influence over cellular processes, and has a decided affinity for glandular and osseous tissues, so that it is very applicable to purulent otorrhœa in scrofulous subjects.

In anæmic and cachectic patients, with long-standing profuse suppuration, much debility, and feeble circulation, it sometimes does wonders.

The particular symptoms demanding the medicine are, coryza and dry sore throat, considerable mucous secretion, and pain when swallowing; the Eustachian tube is full of mucus and inflates with difficulty. There is dulness of hearing, tinnitus of varying quality, coldness of the auricles, sensibility of the ears to cold air and drafts, soreness on pressure in front of the tragus and under the auricle, and a copious flow of straw-colored offensive pus.

The mucous membrane of the tympanum is light red, spongy, covered by large succulent granulations, and, perhaps, shows ulceration; the ossicles are generally gone; the tympanic membrane has a large perforation, and caries of the temporal bone may exist; a sinus may be open upon the mastoid, and discharge the same kind of pus, containing little particles of bone, as in caries of the meatus; the facial nerve may be paralyzed, and the face distorted.

Destructive ulceration is likely to exist, and the constitution to show the effects of the disease by well-marked hectic fever.

Calcareo Carbonica is like the phosphate a nutritive agent, but does not stimulate in the true sense of the word. It aids the organic processes, and has affinities for the glands, ligaments and bones. These properties make it an important agent in the malnutrition of scrofula, and eminently fit it for cases of chronic suppuration of the ear in strumous persons.

It is suitable for these, when the patient chills and sweats easily; there is hyperæsthesia of the skin, eczematous eruptions, swollen lymphatic glands and, perhaps, parotids, irritable sensitive eyes, sore ulcerated nose either very dry or swollen and plugged by decomposing mucus, impaired sense of smell, and occasional epistaxis.

The mucous membrane of the throat and naso-pharynx is congested, œdematous, and relaxed, and secretes a large quantity of dirty white mucus. There is burning in the throat, a sensation of a lump with feeling of constriction; swallowing is sometimes painful, pains shoot through the Eustachian tube, the neck is stiff, and on inflation loose mucous râles are heard.

There may be a coarse sounding tinnitus of a rhythmic variety, owing to the pulsations of congested vessels in the tympanum and adjacent to it; the profuse discharge from the ear is white, flaky, and caseous, of a cheesy odor, and the walls of the canal are white and macerated.

The membrane usually presents a large perforation; the ossicles are carious or absent; the tympanic mucous membrane when cleaned looks pink and flabby, and presents large pale granulations or polypi, which bleed easily when touched; there is considerable sensitiveness to contact, but little soreness around the auri-

cle; ulceration of the mucosa, and caries are frequently present, and the patient presents the appearance of marked dyscrasia.

Calcareo Iodida is another lime medicine, which is appropriate for the same class of cases as the phosphate and carbonate. I have used it after a long trial with the latter, when the disease seemed to be at a standstill, and the mucous lining of the tympanum was indolent. A more acrid pus and greater swelling of the lymphatic glands, occurring in a thin, dark patient, have led me to employ it, and it has frequently proved its curative power.

Capsicum has pathogenetic outlines closely resembling the more acute symptoms of the disease under treatment. Symptoms demanding its employment are, neuralgic pains, lateral headache of great severity, and chilly sensations followed by fever.

There is nasal catarrh, acute or chronic; a dark red, inflamed throat, which burns and stings, and feels constricted on swallowing, and may show a little ulceration. The Eustachian tubes open freely, but inflation causes pain from the throat through the ear.

The auditory canal is reddened, the membrane is perforated, the ossicles may be partially destroyed, the tympanum contains a little pus, and is hot, red and tender. Movement of the auricle causes considerable pain; the mastoid is red, hot, sensitive, and swollen; the whole side of the head aches violently, and keeps the patient restless, feverish, and, perhaps, delirious.

This medicine is highly recommended by Dr. H. C. Houghton, of New York city, in acute exacerbation and sudden extension of old chronic inflammation of the tympanum to the mastoid cells. He has reported numerous cases of unmistakable mastoid inflammation, which have rapidly subsided after the administration of capsicum. After the evidence presented by so close and conscientious an observer as Dr. Houghton, this medicine should be given the first place in the early stages of mastoid inflammation, whether it be periosteal or intra-cellular.

My experience with it is limited, and though I feel bound to try it upon suitable cases, I feel loth to permit it to take the place of such well-proved remedies as Aconite, Belladonna, Kali

brom., and Hepar, because in conjunction with necessary operations they have served me well.

Ferrum Iodidum is well adapted to cases of anæmia from defective digestion, malassimilation, and profound depression of the vital powers, induced partly by the profuse suppuration. When the lymphatic and tonsillar glands are in a condition of chronic engorgement and inflammation, the pus from the ear is thin and bluish, or reddish from the presence of blood; the tympanic mucous membrane is ulcerated, and the temporal bone carious, this alterative nutrient will sometimes arrest the destructive process, and aid in restoring the patient to health. There is very little pain, aural hemorrhage, and hectic, as under Cinchona, but an absence of reactive symptoms, because the powers of the system are at too low an ebb.

Hepar Sulph. Calc. is invaluable in some of the cases under consideration. When there is lassitude, weakness, irritability, chilliness, slight fever, various eruptions not healing readily, inflammation of the lymphatic glands of the neck, lateral or frontal headache, and sore eyes, in strumous patients, this agent is very useful.

It is especially requisite, when the throat feels dry and scraped, the tonsils are hypertrophied, sharp pains extend from the throat to the ear, there is constant hawking of mucus; the external ear and meatus are itching, red, hot, and burning; a vesicular eruption covers the auricle, the cerumen is morbid and excessive, and the Eustachian tube opens imperfectly. There is usually a discharge of thin yellowish-white, cheesy, fetid pus from the ear; a pink, macerated appearance of the canal walls, and a reddened mastoid; aching in the ear and whole side of the head, worse in the cold and at night, with painful sensibility when touched. The canal is often narrowed by swelling of its walls, so that the tympanic membrane and middle ear are invisible; the membrane is perforated, but inflation frequently fails to force air outward, and causes considerable pain. The more acute symptoms mentioned are present in the early stages of purulent inflammation of the tympanum, and in acute exacerbations during the course of the chronic disease. For such attacks, this medicine will be found more appropriate than for the slow painless subacute conditions.

Kali Bichromicum is highly recommended in this disease, but my experience with it has been very unsatisfactory. It is appropriate for cases of mild inflammation of the nose, naso-pharynx, Eustachian tube and tympanum, with a discharge more mucoid than purulent, tough, whitish-yellow and tenacious; it obstructs the Eustachian tube at times so that air cannot be forced through it, and clings to the throat and tympanum in patches and shreds, resembling a false membrane.

The pain in the ear is slight and inconstant, accompanied by itching and warmth, and it shoots through the ear and about the angle of the jaw. The auditory canal is nearly of normal color, the drum-head has a small perforation, the mucous membrane of the tympanum is pink and inactive, and may show a few granulations and shallow, indolent ulcerations.

This medicine is most appropriate for very mild inflammations of the ear, and for chronic cases that are approaching a cure, just as are Graphites, Pulsatilla, Tellurium, and others.

Kali Hydriodicum is an antiplastic of decided power, and it presents iodine to the system in one of its least irritating combinations. It has affinities for the mucous membranes and glands, which render it curative in many morbid conditions. It is likely, in large doses, to irritate the stomach and kidneys and induce a hydræmia, which is opposed to healthy nutrition, and, therefore, must be given in small doses well diluted in water.

It is frequently valuable when there are pains of the muscles, ligaments and bones, aggravated at night; hard knotty lymphatic swellings and œdema, and pustular and furuncular eruptions. There may be acute or chronic nasal catarrh, accompanied by dull pain; inflammation of the pharyngeal follicles and the glands in the naso-pharynx; hypertrophied tonsils; catarrhal inflammation of the Eustachian tube, indicated by noisy inflation or total obstruction; swelling of the submaxillary and cervical glands; heat, redness and a scaly state of the auditory canal, sometimes, accompanied by phlegmonous swellings; periostitis and severe pain; caries and necrosis; paralysis of the facial nerve; a small or medium perforation of the drum-head; muco-purulent discharge of small quantity and variable appearance; crusts and

scales adhering to the perforation and to the smooth, red, moderately inflamed mucous membrane.

These symptoms call for the exhibition of this medicine, especially, when the patient is of a rheumatic or gouty diathesis, or has been afflicted by syphilis.

Kali Phosphoricum is a new medicine for suppurative otitis, introduced to the profession by Dr. Houghton, to whom we are much indebted for careful studies in aural therapeutics. He quotes the following symptoms, arranged by Dr. Walker: "Breath offensive, fetid; tongue coated like brownish liquid mustard; diarrhoea foul, if accompanying any other disease, with putrid evacuations; dysentery, with putrid very offensive stools; evacuations putrid, very offensive smell; intermittent fever; profuse, fetid perspiration; debilitating mastitis; if the pus is brownish, dirty looking, with heavy odor; suppurations dirty, foul matter with offensive odor; toothache with easily bleeding gums. In the muscle cells, fatty metamorphosis; in the muscular juice, or myosin, putrid decomposition; in the blood corpuscles, rapid decomposition; it cures septic conditions, scorbutic bleedings, mortification, putrid smelling diarrhoea, and a dynamic typhoid condition."

Dr. Houghton says, "the dark color and offensive smell of the discharge are the characteristic features. I have used potash in many cases having the above indications, and am gratified at the results obtained. In otitis externa, the epidermis is moist, crusts form and scale off, leaving the canal red and shining, but a few days suffice to form similar crusts; the inner third of the canal and membrane is either filled or the walls are abundantly covered with thick, dark-colored pus, fetid and sometimes grumous or granulous; the tissues when cleaned are rough, easily bleeding or covered with small granulations. In otitis media, the membrane of the tympanic cavity takes on the same type and gives a purulent product free from mucus; the bloodvessels rupture easily, and slight oozing of blood will often follow the most careful cleansing with absorbent cotton, but if the ear is kept dry by daily use of the cotton, and the remedy is given two or three times daily, a change for the better is soon observed. I judge the effect of the salt to be that of removing morbid conditions of the mi-

nute bloodvessels, thus preparing the way for such a remedy as Silicea or Calcareo.*

It is apparent that Kali phos. is applicable to much the same kind of cases as Calc. phos. I have no experience with the former, but shall be inclined to use it in non-strumous patients instead of the Calc. phos., which is so valuable in strumous constitutions.

Mercurius invades all the tissues, increases the secretions, favors elimination, deteriorates the blood, causes hemorrhages, and softens, ulcerates and breaks down the solid structures of the body. It strikes at the animal system by its powerful action upon the vegetative, and gives a life-like picture of scorbutus. When it is indicated, the muscles of the neck are sore and stiff, and the bones are affected by periostitis, nodes, caries and necrosis.

The skin is of a sallow earthy hue, and excoriates and ulcerates easily; the cervical lymphatics are swollen or ulcerated, and the throat is painful to pressure. The nasal fossæ present the different stages of inflammation seen in chronic nasal catarrh; the discharge is thick, scabby and foul; the pharynx is rough, tumid and vascular from the constant irritation of the discharge; the Eustachian tube opens with a noisy rattle, owing to relaxation of the mucous membrane and the profuse discharge; the throat is dark red, its tissues thickened and relaxed, and it secretes much muco-purulent matter.

There are dull pains about the auricle and middle ear; occasional shooting pains in the whole aural region; the discharge from the ear is yellowish-gray pus, mixed with blood and débris of ulcerated tissues; the auditory canal is pale and its lining puffy and moist from the constant flow of purulent matter; the membrana tympani looks like chamois skin, and shows a large perforation; the tympanum is usually full of inspissated pus, forming adhesive caseous patches; when this is cleaned out, the mucosa is seen to be pale red and flabby, and presents large,

* Kali Phosphoricum in Suppurative Otitis. By Henry C. Houghton, M.D., New York City, N. Y. Transactions of the American Institute of Homœopathy, J. C. Burgher, M.D., Secretary. Eichbaum & Co., Pittsburgh, Pa., 1881, page 618.

spongy, vascular granulations, which bleed upon the slightest touch. There may be ulcerations and sinuses in the mucous lining, leading inwards and outwards to carious bone, or it may be elevated by nodes beneath it, or by polypi springing from its surface.

For recent and severe cases, I have found *Mercurius corros.* most efficient. In those of slower progress with plastic exudation and hypertrophy, which it is desirable to remove, the *Merc. iod. flav.* is better. For mild cases without any tendency to hypertrophy or destructive ulceration, the *Merc. sol.* is efficient, and it is the most suitable for administration in powders. I generally rely on these three preparations, and believe they will suffice for most cases in which Mercury is beneficial and curative. Mercury should be pushed for some time, when the ear disease has been caused by syphilis.

Nitric Acid is characterized by prostration, exhaustion, weariness, trembling of the limbs, stiffness and soreness of the muscles, and pain in the joints and bones. There is great sensibility to cold, chilliness, flashes of heat, and itching eruptions of various kinds upon the skin. The tongue is coated white, the breath foul, the stomach and bowels irritated, and the flow of urine increased. The gums and mouth become sore, salivation is increased, the throat sore, the tonsils swollen, and the nasal fossæ affected by chronic catarrh in all stages, from dry irritation to the foul offensive ulceration of *ozæna*. The naso-pharynx is granular and reddened, owing to the nasal slime that flows over it, and the Eustachian tubes open with difficulty or not at all.

The auditory canal is narrowed from swelling of its walls; a thin yellow or brownish pus fills the passage; the drum-head shows a large perforation; the ossicles are carious or have been discharged; the mucous membrane of the middle ear is pale, granular and flabby, and caries of the temporal bone may exist, with shooting pains and tenderness to the touch. The caries is likely to extend along the roof of the canal and through the mastoid process, revealing its presence by an abscess or sinus behind the auricle, and a rough feeling of bare bone to the probe. This lesion is supposed to be the result of an abuse of

Mercury, or of constitutional syphilis, but the connection cannot be proved.

Caries of the mastoid process is in most cases the result of neglected disease of the middle ear, and may affect the most robust constitution, though scrofula predisposes greatly to it, as it does to many other bone diseases.

Rhus Toxicodendron seems to fill a gap in therapeutics, that no other medicine can. I should seek far before employing it in purulent otitis, occurring in strumous constitutions; but in strong, well-developed persons of bilious temperament, suffering from the disease, it is occasionally very useful.

The symptoms that call for it may be briefly stated. There is a sore bruised feeling in the muscles, with stiffness and pain about the joints. The skin of the face is dusky red, the arterial capillaries of the cheeks and side of the nose are dilated. Erysipelatous inflammation occurs occasionally upon the face and head, accompanied by vesicles, pustules and œdema; the auricle may be thickened and stiff and the lobe tumefied; the mastoid red and tender, and the cervical glands and parotids swollen.

The throat is dry, red, thickened, and sore; swallowing is difficult; sharp pains shoot from the throat to the ear and neck; the Eustachian tube opens freely to inflation, but the operation causes considerable pain in the throat and ear. The purulent discharge is small and cakes somewhat in the tympanum; the external canal is red and scaly; the membrane shows a moderate-sized perforation, and the mucous membrane appears smooth, vascular and shining after the pus has been removed.

The patients are of a rheumatic or gouty diathesis, often broken in health from intemperance and exposure, and suffer in various ways during damp or inclement weather.

Silicea acts upon the skin, mucous membranes, glands and bones. Among symptoms demanding its use are, weakness, heaviness and pain in the limbs; a feeling of general weariness and debility; sensitiveness to cold; slight febrile symptoms; headache, arising in the neck and occiput and extending forwards to the right eye, and much sweating of the head.

The skin is unhealthy, prone to eruptions that suppurate excessively, and show little disposition to heal. The muscles are

stiff and sore, and the bones sometimes affected by periostitis, eburnation, nodes and caries.

The nose and naso-pharynx are in a condition of catarrh. inflammation; the throat and pharynx are dry and hyperæmic; crusts of altered mucus from the posterior nares, parade down the pharynx and keep it irritated; swallowing may be painful and cause shootings into the ear; the Eustachian tube opens noisily and with difficulty. The auricle and aural region may present an eczematous eruption, which has arisen *de novo*, or has been caused by permitting discharges from the middle ear to come in contact with the parts; the auditory canal itches and burns; its epidermis is partially macerated and shreddy; the surface beneath is pink, and a thin or thick yellowish-white pus, containing papery pieces of epithelium, fills the passage. The drum-head is largely perforated; the ossicles generally destroyed; the mucous membrane is pink and granular, perhaps, showing ulcers or a polypus; caries may exist in the walls of the tympanum, the roof of the canal, and the mastoid process, and the facial nerve be paralyzed.

According to the pathogenesis, Silicea finds its sphere of action in scrofulous patients, in whom purulent suppuration of the tympanum frequently runs a very destructive course.

Dr. Houghton thinks Silicea acts upon the substantia propria, or the fibrous middle layer, of the membrana tympani, and favors the healing of perforations.

Sulphur has a pathogenesis which resembles that of Silicea in some respects, and it may be given as an intercurrent remedy in some cases of this disease.

Terebinthina has been lauded elsewhere as a local application, and should be given internally oftener than it is. It possesses the stimulating, yet, soothing properties of a balsam, and has a strong affinity for the mucous membranes.

It is of value in general debility, heaviness and stiffness of the limbs; irritation of the digestive and urinary tracts; eczematous eruptions upon the skin; slight feverish reaction, peevishness and restlessness; fulness of the head and ears; hyperæmia of the nasal mucous membrane with nose bleed; roughness and dryness of the throat; burning soreness and swelling of the gums; diffi-

cult dentition of children, and a moderate flow of thin yellowish pus from the ear, which alternates sometimes with an eczematous eruption on the head.

The eczema may have extended into the auditory canal, and caused ulceration of the drum-head, and purulent inflammation of the tympanum. The perforation is of moderate size; the mucous membrane within red, shining and smooth, and the ossicles are frequently unaffected. Dr. Cooper, of London, England, recommends this medicine strongly for infantile cases, where dentition, otalgia, and purulent inflammation make the morbid picture.

Quite a number of other medicines have been recommended for this disease, but the symptoms that have led to their selection have not been clearly stated, and until they are, reliance had better be placed upon those mentioned.

It is necessary to resort to medicines, noticed under acute inflammation of the tympanum, in case violent symptoms supervene at any time from cold, obstruction, etc. When the purulent inflammation is greatly diminished, and the disease approaches a cure, higher potencies should be given, until the last trace of disease that is curable has vanished.

The Artificial Membrana Tympani.—An artificial membrana tympani, or drum-head, has been employed for a long time

FIG. 76.



TOYNBEE'S ARTIFICIAL MEMBRANA TYMPANI.

in aural practice. An American discovered that a piece of paper pushed in his diseased ears improved his hearing. Dr. Yearsley, an Englishman, took the hint from the gentleman, substituted a pellet of cotton for the paper, and introduced the method to the profession.

Mr. Toynbee improved upon this idea and invented the instrument which bears his name. It consists of a thin, flexible rubber disk having a central eyelet plate of silver, in which is inserted the end of a short slender wire. The latter is merely for the purpose of placing it in position and withdrawing it at

pleasure. Various modifications of this instrument have been suggested by aural surgeons, but it remains to-day the favorite apparatus for the purpose for which it was invented.

The extemporized drum-head, be it cotton or a disk of rubber, subserves two purposes: it protects the tympanum from dirt and air, and concentrates and transmits vibrations to the parts within. The mucous membrane is kept in nearly a normal condition, and the hearing power may be considerably increased.

The conditions in which an artificial drum-head may be used with benefit are:

1. In cases of perforation of the membrana tympani, even, when only a mere rim remains around the periphery.
2. When the handle of the malleus or its short process, with a little triangle of the membrane is still in connection with the chain of bones.
3. When the malleus is lost, and the incus and stapes are still in proper position.
4. When the incus and, perhaps, part of the stapes have been destroyed, but the plate of the stapes is still movable in the oval foramen, and more or less of its limbs project outwards.
5. In some exceptional cases of relaxation and pouching outwards of the drum-head.

An artificial drum-head is contra-indicated:

1. When the ossicles, with the exception of the foot-plate of the stapes, are absent, and the tympanic mucous membrane is thickened and degenerated.
2. When the ossicles are immovably ankylosed.
3. When the remainder of a damaged membrana tympani is firmly adherent to the ossicles and inner wall of the tympanum.
4. When there is paralysis of the auditory nerve.
5. When the patient does not exercise great care to keep the ears clean, and the drum-head properly adjusted.
6. When it causes much irritation, and does not improve the hearing.

Application of the Cotton Drum-head.—A little wad of clean absorbent cotton should be moulded into a disk of the diameter of the inner end of the auditory canal, and moistened with equal parts of glycerine and water or smeared with vaseline.

The ear should then be illuminated by the head mirror, and the cotton taken by the small angular forceps and placed directly upon the parts in continuity with the stapes. It may rest upon the stapes, incus, malleus or membrana tympani, or fragments of one of them; and by repeated changes of its position and pressure, one must determine where it should be to improve the hearing the most. Sometimes it should rest lightly upon its supports; again it should be pressed down into a firm compact layer. No description can convey an exact idea of the manipulation necessary, as the requirements of cases are so different.

It is better to use the pledget of cotton in all cases until the parts become accustomed to the presence of a foreign body; then the rubber membrane may be applied, if deemed applicable.

When the ear is running it should be syringed, have an astringent wash applied, and a fresh piece of cotton introduced once a day. When it is dry the cotton should be changed once a week.

After toleration is established, it may be left in position longer, but the patient should report to the physician if he feels any discomfort in the ear, in order that proper treatment may be instituted.

The physician ought to apply the drum-head for a time, during which he keeps watch of the case, and if all goes well, instruct the patient how to adjust the thing himself.

Application of Toynbee's Artificial Membrana Tympani.—The rubber disk is much easier placed in proper relation with the parts than the cotton pledget. It is generally too large, as furnished by the instrument-makers, and is to be trimmed with the scissors to fit the inner end of the canal as closely as possible. Take it by the wire stem and push it into the canal until by inspection and resistance it is known to rest upon the damaged membrana tympani or ossicles. Then turn it around a little, press it up, down or horizontally till hearing improves. The patient ought to be instructed early how to place it in position, and should remove it every night, for a week or two, to lessen the irritation. He should keep the canal scrupulously clean, and ought to change the instrument for a new one every month, as it shrivels and hardens in dry ears if left too long.

The artificial drum-head receives all the vibrations of sound which enter the auditory canal, and resting upon a part of the membrana tympani, one or more ossicles, or a fragment of one of them, it augments the receptive and transmitting power and the agitation of the contents of the labyrinth.

It presses the ossicles together, when from any cause their ligaments are relaxed and articular parts separated, and steadies and supports a membrane, thinned by atrophy and improper inflation.

It protects the exposed tympanum from extraneous substances and changes of temperature, relieves painful sensibility, and is thought to favor the cure of purulent inflammation.

It improves the hearing frequently by concentrating vibrations upon the oval and round windows of the labyrinth, which without its intervention would be scattered and lost in a measure upon the walls of an insensitive and inappreciative tympanum.

It is advisable to apply an artificial drum-head tentatively to every case of deafness where it seems applicable. Indeed, in some cases of deafness, the hearing is improved by it, when the conditions would lead one to suppose it could not render any service. A careful trial can do no harm, and the afflicted patients should be given all the chances.

It is a mooted question, whether it is advisable to employ an artificial drum-head in chronic purulent inflammation of the tympanum, for the purpose of increasing the hearing. It causes some irritation, obstructs the outward flow of pus, interferes with the interchange of gases, and hinders aeration and oxidation.

These are all effects which tend to aggravate the disease instead of promoting a cure, as maintained by some authors.

On the contrary, the hearing is improved more or less, according to the condition of the tympanum.

An intelligent patient with troublesome deafness, whose hearing and chances of livelihood are improved by a cotton drum-head, may use one, provided he cleanses the ear thoroughly, applies an astringent wash, and introduces a fresh piece of cotton every day. A piece of absorbent cotton, wet with equal parts of glycerine and water, or sometimes with undiluted glycerine, is generally used, and cases are on record in which it has proved very effectual in improving the hearing.

The hearing is better in most purulent otorrhœas, when the discharge is thin and copious. Let the matter become inspissated and the tympanum a little dry, and the hearing will decline. The saturating fluid used with the cotton probably causes a freer and thinner discharge by stimulating the mucous membrane, which becomes more flexible; the round and oval foramina membranes then act with greater freedom.

An intelligent consideration of the principles enunciated, and a careful adherence to means and methods described, will enable one to improve the hearing by the artificial membrana tympani in a limited number of cases.

CHAPTER VII.

COMPLICATIONS OF CHRONIC PURULENT INFLAMMATION OF THE TYMPANUM.

Polypi.—In a previous section, it has been stated, that granulations and polypi arise very frequently upon the tympanic mucous membrane of a suppurating ear, especially, when the ear has not been treated, and the parts have been for a long time soaking in decomposing pus and inflammatory débris. Polypi seldom arise when the parts are kept clean by frequent syringing, even, with simple water.

Granulations are exceedingly common, but the larger granulations and distinct tumors, which have been dignified by the title of polypi on account of their fancied resemblance to animals of the sub-kingdom of coelenterate radiates, are not common.

In the seventy cases of purulent otitis, that have been under my treatment during the last three years, only six were complicated by polypus. Two were of the firm fibrous kind, and the other four were of the mucous variety.

Polypi vary in size from that of a grain of rice to the diameter of the meatus, and may be increased in length to that of the auditory canal.

They are most frequently seen upon the anterior half of the inner wall of the tympanum, near the opening of the Eustachian tube, and this elective preference, so favorable to a continuation of the functions of the round and oval membranes and ossicles, is due to the fact, that the muciparous glands of this region are much larger than in any other part of the mucous lining. Polypi may spring, however, from any part of the tympanum, from the walls, the tympanic mouth of the Eustachian tube, the mastoid cells, the surface of one of the ossicles, the inner surface of the membrana tympani, the edge of its perforation, and breaks in the continuity of the skin of the auditory canal. A case is recorded, in which the movement of a polypus in the tympanum

caused lateral movements of the eyes, and it was supposed to be connected with the dura mater, probably through a fissure in the roof, or an unnatural patency of the petroso-squamosal suture.

Polypi generally occur singly, but there may be quite a group of various sizes, crowding each other for space and nourishment. They take different shapes, round, club, and bottle-shaped, according to conditions around. They may lie closely in depressions, or project in different directions; they frequently extend outwards through a perforation in the membrane, occasionally, including one of the ossicles, fill the entire tympanum, displace the ossicles, occlude the canal and meatus, and may exercise sufficient pressure to enlarge the osseous or cartilaginous portion of the canal.

Polypi interfere with sound vibrations, cause a stopped feeling, and injure the hearing. They are often accompanied by pulsating tinnitus from congestion, heavy head, vertigo, nausea, and pain in the head, which extends down the side of the neck and along the arm. They have produced hemiplegia, but often present few symptoms; they increase the irritation and discharge, prevent proper treatment of the diseased mucous membrane, and sometimes obstruct the outward flow of pus, which, seeking an outlet, may get into the mastoid cells, the lateral sinus or the brain case, and cause fatal disease.

There are four kinds of aural polyps; two so rare as to be curiosities, and two common and well known to aural surgeons. The varieties are the Angioma, Myxoma, Fibroma, and the Mucous.

Angiomas are soft, red, irregular-shaped growths, arising in the mucous membrane of the tympanum; they are composed of a newly formed network, or mesh of bloodvessels, held together by considerable connective tissue; contain blood corpuscles in the spaces, and are covered by pavement epithelium. Venous tumor, or vascular nævus, of a bluish hue and little elevated has been seen upon the inner wall of the tympanum. When these growths are punctured or torn, copious and alarming hemorrhage sometimes ensues, and the physician must be prepared to combat it. This variety is fortunately very rare, only two or three cases having, as yet, been reported.

Myxomas resemble in their coarse aspects the ordinary mucous polypi, and the microscope must be brought to bear upon a section before a certain diagnosis can be made. Myxomas in the tympanum consist of structureless mucin jelly, held together by an anastomosing network of spindle and irregular stellate cells, and a liberal intermixture of finer fibres; they have a few blood-vessels, contain some round, granular, nucleated cells like lymph corpuscles; are covered by pavement epithelium, and feel soft and smooth.

Schwartzke thinks these tumors may be developed from the mucous tissue, known to fill the tympanum at birth, under the stimulation of tympanic disease to which the infant is so subject. They are very rare and easily mistaken.

Fibromas originate in the periosteum of the tympanum, and push the mucous membrane outward as they develop. They are composed of dense connective tissue fibres, with anastomosing stellate and spindle cells; are sparingly supplied with bloodvessels, and covered by several layers of pavement epithelium, into which fibrous papillæ project as in the skin. They do not show papillæ upon the surface, but look bluish-gray, smooth and tough like callous skin. No glands or cysts are found within these growths, the glands of the expanded and thinned mucous membrane having been strangled by the pressure of the dense fibrous tissue.

This variety of tumor is seen next in frequency to the mucous polypus, and is easily recognized after cleaning by the color, consistency and dry-looking surface. They resist Wilde-Blake's snare, and I have known instances where the usual silver wire was broken in attempts to cut them through a little outside of the base. They affect rheumatic and gouty patients by preference, and grow very slowly.

Mucous polypi are granulations run riot, and they are more frequently seen than the three previous kinds altogether. They are purple, pale pink, bluish-red, raspberry-red or crimson in color; their surface is smooth and glistening, a little papillary or lobulated; it is covered at the base with cylindrical, sometimes, ciliated epithelium, and on other portions of the surface by that of the pavement variety. This is many layers thick, and here and there sends tubular processes of epithelial cells into the tumor,

so that a section has an appearance something like that of an epithelioma. These tubular processes are hyperplastic formations of the glands of the tympanic mucous membrane.

Cysts, lined and filled by epithelium and mucous fluid, sometimes exist in these polypi, owing to closure of the tubular glands, thus forming true retention cysts.

The substance of the growths consists of ordinary loose connective tissue, with spindle and stellate cells, containing in the interspaces many granular cells and much mucin. Bloodvessels enter the base of polypi, run through the centre, and distribute branches to all sides quite freely, so that upon removal there is frequently a copious hemorrhage. These tumors grow very fast, and spring up rapidly after removal; they often ulcerate upon the outer extremity, and are the kind generally found in diseased ears of scrofulous patients.

The diagnosis of a polypus is generally an easy affair. The ear should be syringed and wiped clean, a speculum introduced, and the parts illuminated and examined. A fine probe or a platinum wire loop will inform one of the consistence, mobility, size and attachment of the growth, as it can be pushed between the tumor and the canal walls, and moved about freely in most cases. The spot from which the growth springs should be determined as nearly as possible, so that a snare for removal may be applied properly. Occasionally it is difficult to find out the exact spot of implantation. Polypi have arisen in the canal, extended into the tympanum, and perforated the windows of the labyrinth, and the mastoid antrum; but they are generally rooted in a deeper position than their projecting surface.

Treatment.—Aural polypi should be removed as soon as discovered and as often as they recur. Unless this is done, it will be impossible to cure the diseased mucous membrane, or to insure the safety of the patient.

The growths are sometimes constricted and cut off by the edge of a perforation in the membrane, and the pressure of pus behind, and there is no doubt they sometimes undergo ulceration at the base, as they do upon the outward aspect, and are thus discharged spontaneously or upon the first attempt at syringing. These results are rare, however, but when they do occur, they should

not be accredited to the action of any medicine given internally, as has been done by some writers with more credulity than scientific knowledge.

There are three methods of removing polypi from the ear, which I will designate as the desiccating, the cauterizing, and the surgical. The angiomas and myxomas are so seldom encountered, that in treatment I will consider them with the mucous growths, as soft polypi, and will call the fibromas the fibrous polypi. It is well to be prepared with hæmostatics at all times, but, especially, when removing an angioma, or nævus, as copious hemorrhage may be expected, that is sometimes very obstinate.

Recurrence may be predicated of the myxomas, but all polypi are likely to sprout up again after removal, so that in all cases the total destruction of the morbid growths should be insured.

Soft polypi of small size may frequently be made to disappear under the continuous action of astringent solutions, instilled daily. The remedy constricts the tissue and vessels of the growth, which desiccates, shrivels and finally disappears, while at the same time the solution causes granulations to undergo the same process, and the mucous membrane to take on a healthier action.

Alum, sulphate of zinc or sulphate of copper, in solutions of ten to fifteen grains to the ounce of water, may be instilled in the ear twice a day under the physician's supervision, until the object is effected, or it becomes evident that the growths cannot be removed in this manner. The strength of the solution must be diminished, should too much irritation ensue; the action upon a tumor may be increased by pricking it with a cataract needle, as suggested by Dr. Roosa. This desiccating method is very suitable for fractious children, and ought to be tried in suitable cases.

Soft polypi of moderate size may often be destroyed rapidly by caustic applications made by the physician. The pure solution of subsulphate of iron, a saturated solution of nitrate of silver, chromic or nitric acid, and burnt alum, are most appropriate for the purpose. The last remedy ought to be blown or placed upon the tumor every day, and kept there in the intervals of application by a pledget of cotton. The other agents should be applied by a tuft of cotton upon the holder, as already described, and, after a few minutes interval, the ear should be syringed with tepid water, dried carefully with cotton, and a

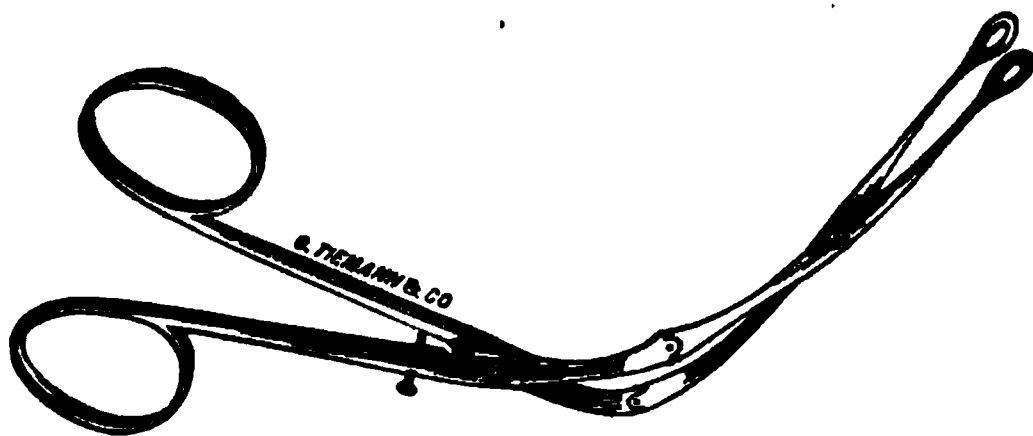
pledget of cotton left in the ear to catch the drainage from the slough, which will otherwise excoriate the meatus; the warm douche should be used frequently to cleanse the parts.

Fragments of a polypus may be removed by forceps, the roots of the growth cauterized till all disappear, and then the treatment adapted to the condition of the mucous membrane carried on to the end.

When a polypus cannot be removed in any of these ways; when it is of goodly size and easily seized, especially, if it is of the fibrous variety, and the patient is old enough to be managed easily, it is better to resort to surgical measures.

The instruments necessary are few and inexpensive. The angular forceps, and the Pomeroy forceps have been already figured.

FIG. 77.



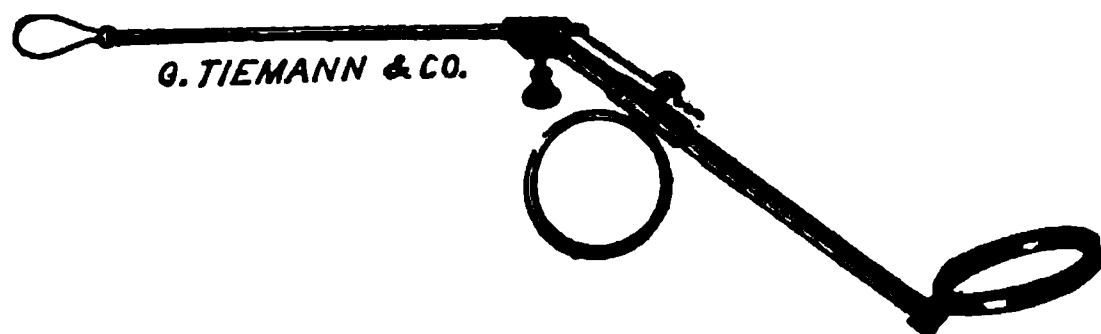
HINTON'S POLYPUS FORCEPS.

Hinton's ring polypus forceps have the blades fenestrated; they do not slip when the growth is seized, and they are bent at an angle like the others, so that the hand does not interfere with illumination.

The polypus and surrounding parts should be well lighted up by the head-mirror. Small polypi may be pinched and twisted off by the toothed forceps. Larger ones, flat, round or oval, should be seized and crushed with the Pomeroy or Hinton forceps, and twisted around and freed from their base by the exercise of a little dexterity, without removing the surrounding tissues to an injurious extent. A little more care must be exercised in extirpating the fibrous growths, as they have deep and strong attachments. Most fibrous polypi and soft polypi of such a shape and size, that a loop of wire can be slipped over them down to the base, ought to be cut off by the Wilde-Blake snare.

This consists of a small square rod of steel, with a fixed ring upon one end for the thumb, and a socket in the other, into which fits at an obtuse angle a slender steel tube. Upon the square rod is a sliding canula, having a ring for the forefinger beneath, and a button above, to which is fastened the ends of a fine silver wire.

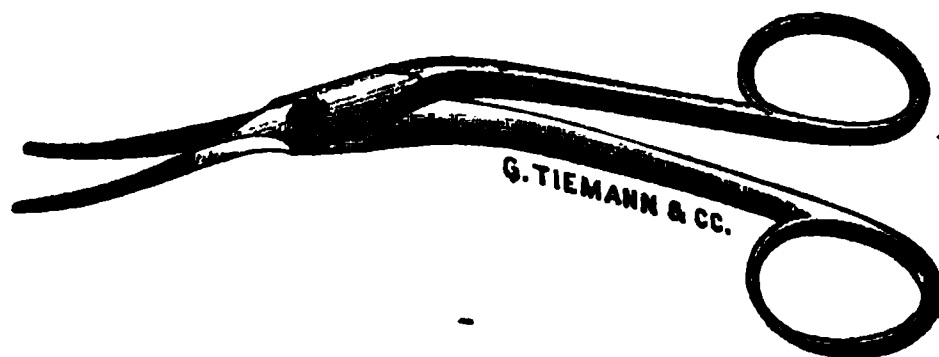
FIG. 78.



WILDE-BLAKE'S SNARE.

This double wire passes through the tube and projects in a loop from the distal end. When the instrument is held properly, and the forefinger is drawn towards the palm of the hand, as in pulling the trigger of a pistol, the wire is drawn upon, and the loop made smaller. When the loop is around a polypus, this action will cut it off clean, and bruise the base enough to limit the hemorrhage.

FIG. 79.



POLYPUS SCISSORS.

To remove a polypus with this admirable instrument, illuminate the parts by the mirror, without introducing the speculum, slip the wire loop far in over the growth, with the tube upon the side where there is most room, hold the instrument firmly, and pull the canula ring towards the hand by the forefinger. This will generally cut the polypus off at its base, and it will fall out as the instrument is withdrawn.

Some fibrous polypi break the wire of the snare, and are so dense and tough, that they require removal piecemeal by forceps,

knife, and blunt pointed scissors. A special pair of scissors with blunt, curved blades will prove useful occasionally.

Polypi are insensitive growths, and there will be little pain from crushing or cutting them, but the canal and tympanum are hypersensitive, and the manipulation for this and other reasons should be very gentle.

Hemorrhage after abscission or removal by other means is generally slight. I usually inject the ear with cold water, until the blood ceases to flow, then dry the ear with absorbent cotton, and touch the base of the polypus, and any large granulations that may be near, with one of the cauterants previously mentioned. The excess of this is to be washed away, the canal again dried, and a tuft of absorbent cotton pushed in as a protection from cold and drainage.

The roots, or base, must be cauterized until the surface is smooth and the tendency to relapse is arrested, and it is better to use simple water douches, three or four times a day, to remove slough and matter, as long as the severe measures are necessary. Later, the astringents and stimulants appropriate to the case, and the measures described under chronic purulent inflammation are to be employed.

In case hemorrhage should persist after the removal of a polypus, plug the ear tightly with styptic cotton and apply a pressure bandage. If this should not arrest the blood, a saturated solution of tannic acid, or the officinal solution of subsulphate of iron may be injected into the ear.

In a severe case, occurring in a plethoric patient at my clinic at the Pittsburgh Hospital from removal of a mucous polypus, after these measures had all failed, and the patient had lost half a pint of blood, I arrested the flow by tamponing the canal with wads of moist cotton, rolled in pure tannic acid. These were removed the next day, a cauterant applied, and the woman was finally discharged cured.

Other Tumors.—There are other growths occasionally seen in the tympanum and temporal bone during purulent inflammation, either as the consequence or the cause of it.

Cholesteatoma may arise in the temporal bone or tympanic

mucous membrane, and appear as small pearly gray tumors, which gradually increase, extend into surrounding parts and project outwards into the canal, looking not unlike a fibrous polypus.

The tumor consists of a loose mass of fatty epithelium, cholesterol crystals, threads of fungus, pus cells, and inflammatory débris. This caseous matter increases rapidly; sometimes penetrates the mastoid cells, the Fallopian canal, the labyrinth, and the internal auditory meatus, causing paralysis of individual nerves and meningitis.

Epithelioma is the most common of all the malignant diseases of the tympanum, and arises from purulent disease of the mucous membrane. This is another fact that shows the necessity of local treatment in all such cases.

Carcinoma and Sarcoma.—Medullary and scirrhus carcinomas, and spindle-celled and osteoid sarcomas arise within the ear, and invade and destroy the internal ear and mastoid cells; or they may originate in the parotid, in a cervical gland, or in the tissues around the auricle, and extend into the temporal bone and brain, causing destruction of the ear, and fatal cerebral disease.

Treatment.—The treatment of these adventitious growths must be active and radical. Extirpate all of the morbid tumor possible, cauterize the wound with one of the acids or the actual cautery, keep the parts wet with a solution of carbolic acid and glycerine, one part to sixty, and treat morbid constitutional symptoms as expeditiously as possible.

Arsenicum iod. and Kali hydriod. are considered the most useful remedies against malignant growths.

Exostoses.—Exostoses occur upon the ossicles and the tympanic walls occasionally, during the course of a purulent inflammation, though their usual seat is upon the wall of the external canal. It must be remembered, that the mucous membrane of the tympanum and its periosteum are so intimately blended, as to form practically one covering for the bone, and a serious inflammation of this dual membrane includes two processes: a superficial affection with increased secretion, and a periostitis with a tendency to ossific deposit upon the bone.

In every kind of inflammation of the middle ear, there is a

liability to hyperostosis or exostosis, and it is probable some slight increase of the bone takes place in most cases, though it is often impossible to recognize it. It is only when the deposit is considerable in amount, or occurs in small circumscribed swellings, nodules or spiculæ, that one can make a positive diagnosis. Even then one must study the history, and remember that they may not be new, for bony tumors of all sizes, even, filling the entire tympanum, are occasionally congenital.

There is generally a heavy, stopped feeling in the ear; diminished hearing, and if inflammation exists, a dull throbbing pain.

The tumors are generally pinkish or yellowish-white, smooth and shining, and, if the parts are clean, they attract the attention immediately. They occur most frequently in scrofulous constitutions, and are often accompanied by chronic suppuration of the mucous membrane, and fistulous openings leading to carious bone.

I had a boy under treatment for chronic purulent inflammation of both ears, of seven years duration, resulting from scarlatina. The drum-heads and ossicles were gone, the mucous membrane was succulent and granular, and nodular exostoses projected from the inner wall and the floor of each ear, thus diminishing the cavities considerably. The watch could not be heard on contact, but loud voice and the fork were appreciated, and inflation caused a low hiss from each ear. There was pain and tenderness, but no fistulæ nor caries.

Rheumatism and gout are charged with promoting the growth of these tumors, and it is very natural to conclude, that diatheses which are recognized by inflammatory tendencies of fibrous tissues, the periosteum, fasciæ, ligaments, tendons, etc., should not leave the middle ear unaffected. I have already mentioned that they promote the growth of fibrous polypi in purulent otitis, and this hypertrophy of fibrous tissue outwards must be accompanied by more or less ossific deposit beneath.

In the sclerosis of the tympanic mucous membrane, and the hypertrophy which accompanies this condition and chronic catarrh of the tympanum and tube, hyperostosis is a frequent occurrence, and often renders efforts for the restoration of hearing nugatory.

Sometimes this hyperostosis entirely solidifies the mastoid cells, and consolidates the process into a condition of eburnation. The most remarkable case of intra-tympanic exostosis I have ever

seen was in a woman, 30 years old, with a decidedly gouty diathesis. She was well developed, fleshy, and plethoric; of nervobilious temperament, florid complexion, and intelligent mien. She had been married eight years without having conceived, owing probably to conical cervix and narrow os tincæ, and suffered frequently from disordered digestion, and rheumatic pains in the extremities.

She had had scarlatina in infancy complicated by purulent inflammation of the middle ears, which had continued some months and then ceased spontaneously.

Upon examination, I found R. E. Hw. $\frac{x}{80}$; L. E. $\frac{o}{80}$. The patient heard loud voice, and the fork upon the vertex was heard clearly, and best on the left side.

The right auditory canal was dry and nearly normal. The drum-head was whitish-gray, much depressed, irregularly wrinkled, and adherent to the promontory around the foreshortened and firmly fixed malleus handle.

Its periphery had a wide border of yellow fibrous thickening and degeneration, and two distinct, small round exostoses, one from above the oval window, the other from below and in front of the promontory, pushed the drum-head outward. A balloon of membrane the size of half a grain of rice, situated below and behind the promontory, was lifted by inflation, showing that the Eustachian tube was pervious and the tympanum not entirely obliterated.

The condition upon the left side was even more remarkable. The canal was dry and without cerumen, but tolerably healthy; the drum-head was smooth and dirty white, except a small perpendicular band of gray along the malleus handle and around the short process. It was firmly adherent throughout its extent to the inner tympanic wall, and strong inflation did not raise a fibre. The adhesion over the promontory embraced in a sulcus the displaced malleus. The anterior and posterior portions of the tympanum were each filled by a yellowish-white, smooth, rather flat exostosis, springing from the inner wall and extending outwards to the inner end of the auditory canal, and having the respective segments of the drum-head stretched firmly over them. The outer surfaces of these growths were inclined towards each other

nearly at a right angle, the central thinner portions formed the border of the vertical sulcus of gray membrana tympani before mentioned. A probe passed along the anterior and posterior walls of the auditory canal struck the tumors upon a level with the annulus; when moved to the centre of the canal, it passed deeper until arrested by the membrane and malleus in the sulcus between the tumors, and upon the inner tympanic wall.

Exostoses in the tympanum may attain a certain size and become stationary, or increase until they destroy the conducting apparatus and cause total deafness. They are dangerous when associated with purulent inflammation, as they may obstruct the outward flow of pus, and induce mastoid and cerebral disease.

Treatment.—Treatment is of little avail for the removal of exostoses in the tympanum, and he would be a rash surgeon, who should attempt it by mechanical means, unless it was a question of life or death.

It might become necessary to bore through or chisel away an obstruction, when a close study of the conditions, and the principles of conservative surgery must guide the man upon whom the great responsibility falls. Fortunately the occasion is extremely rare.

Any disease of the ear should be treated according to directions given elsewhere, and the diathesis of the patient should be duly considered in the selection of medicines.

The reader is referred to the article upon exostoses in the external auditory canal.

Paralysis of the Facial Nerve.—This complication occurs occasionally in disease of the ear. The nerve passes through the Fallopian canal in such close proximity to the tympanum, antrum, and mastoid cells, that inflammation in these cavities, effusions into the cellular spaces, and caries of the temporal bone are liable to exert pressure upon its fibres, and, even, to destroy their continuity.

Periostitis and exostosis, affecting the internal auditory meatus or the Fallopian canal; the use of strong caustics in the tympanum, when the nerve trunk is exposed by caries; traumatic injury of the bone; cerebral disease, and tumors have caused paralysis of the facial nerve.

The symptoms of paralysis are easily recognized, and variations in them enable one to determine with considerable certainty the locality of the morbid process upon which the lesion depends.

The general symptoms are paralysis of the side of the face; immobility of the features of the one, in strange contrast to the mobility and expression of the other side; inability to close the eyelids, the mouth drawn to the opposite side, the cheek relaxed so that food remains between it and the teeth; occasionally, drooping of one-half the velum palati, pointing of the uvula to the paralyzed side, and tingling and defective general and special sensibility in the lateral portion of the tongue. To these may be added deafness, tinnitus, and a heavy feeling in one-half of the head.

Intra-cranial disease affecting the facial will, also, injure the softer auditory nerve. There will then be paralysis of the stapedius muscle; some deafness and, perhaps, tinnitus, from a disturbance of the correlated action of this and the tensor tympani muscle; relaxation of the soft palate, paralysis of the chorda tympani, with its phenomena of numbness, semi-lateral loss of taste, and increased salivary secretion; and immobility of the auricular, facial and other muscles to which the fibres of the portio dura are distributed.

Lesion of the auditory nerve will be apparent by partial or complete loss of hearing of the tuning-fork, vibrating upon the mastoid and vertex. To these significant symptoms will be added paralysis of other cranial nerves, or such disturbances of cerebral functions as to render the diagnosis easy.

When the facial and auditory nerves furnish the characteristic symptoms of paralysis, without any signs of cerebral disorder, the lesion will probably be found in the internal auditory meatus.

When the auditory nerve is little affected, as shown by the tuning-fork, and the facial with its chorda tympani is paralyzed, the lesion will be in the Fallopian canal, between the internal auditory meatus and the place where the chorda is given off.

When with paralysis of the face, the chorda tympani is unaffected, the lesion will be found below the place where it leaves the facial.

The facial is sometimes temporarily paralyzed by exposure to

severe cold, in which peripheral fibres only are supposed to be affected, and no affection of the bone can be demonstrated. There is no doubt congestion of the perineurium or of the periosteum in the mastoid, which causes pressure upon the nerve at the stylo-mastoid foramen, or a little ways up the Fallopian canal. The prognosis depends much upon the cause of the paralysis, but, in general, is more favorable in recent than in chronic cases, in youth than in mature age, in the strong and healthy, than in the strumous and feeble. Paralysis from cold, acute inflammation in the tympanum and mastoid cells, and application of strong caustics is more amenable to treatment, than that occasioned by trauma, caries, and intra-cranial disease.

Treatment.—No special treatment is recommended for the nerve, but that most appropriate for the morbid condition connected with the paralysis offers the best prospect of a cure.

Mastoid Disease.—The mastoid process in the adult consists of a shell of compact bone, inclosing a group of large communicating cells, which extend above, behind, below, and outside of the middle ear and the inner end of the external canal. The cells on a level with the tympanum are horizontal, and those below them are arranged perpendicularly.

The compact tissue is covered outside by periosteum, and the cellular spaces are lined by a periosteal mucous membrane, continuous with that of the tympanum through the antrum and other openings in the posterior wall. This continuity of mucous surface renders the mastoid cells liable to inflammation, whenever the tympanum is thus affected. Probably they are inflamed to some degree in all severe cases, as mastoid disease has occurred rarely with the membrana tympani intact, but the treatment instituted for the middle ear disease usually relieves the mastoid complication before it has reached a stage to give characteristic symptoms, or to require particular attention. The results are not always so happy, however, and the secondary inflammation goes on until it merits a special designation, as mastoid disease. Owing to a rudimentary condition of the mastoid in children, they are subject to a less dangerous affection than grown people, which usually ends in caries above and behind the external meatus.

It cannot be affirmed with certainty, that inflammation of the mastoid cells ever occurs disconnected from a morbid state of the tympanum, but this condition may vary greatly in different individuals, and caries of the temporal bone exist, even, without the membrana tympani being perforated.

One may enumerate as causes of mastoid disease : acute inflammation of the tympanum ; acute exacerbation of chronic inflammation ; stuffing of the cells with pus and the débris of tympanic suppuration ; purulent inflammation of the middle ear, with obstruction in the external canal to the escape of pus on account of a polypus, a sequestrum of bone, an acute swelling or exostosis ; and caries of the bone, arising in broken or strumous constitutions.

The symptoms of mastoid disease are sufficiently well marked to attract early attention. During the course of one of the aural diseases above mentioned, owing to exposure to cold, too strong an instillation in the ear, a blow upon the head, or some of the local conditions mentioned, increased congestion of the mucous membrane of the tympanum and mastoid cells supervenes. Any discharge that has previously existed from the auditory canal diminishes or ceases, not always, however ; a heavy aching pain begins deep in the ear and mastoid, and extends to the occiput ; sharp intermitting pains shoot through the side of the head ; the skin over the mastoid becomes red, slightly swollen, and sensitive to the touch, and the patient feels chilly, uncomfortable and sick.

The signs of acute disease may now subside, owing to spontaneous removal of the cause, or to the general treatment adopted ; the tissues behind the auricle may lose their congestion, and the milder symptoms of the primarily affected tissues become prominent.

A free incision through the tissues over the mastoid may empty the engorged vessels, and relieve the compression of the unyielding periosteum, so that amelioration of the symptoms may ensue, and the mastoid complications gradually disappear.

The symptoms may not reach a higher grade than I have mentioned. The compact surface of the mammillated process may yield to the pressure from the exudation within the cells, the painful and dangerous symptoms disappear, a small tract of bone become carious, the purulent products pass through the posterior

wall of the auditory canal and run out of the meatus, or distend the tissues upon and below the mastoid, and form a post-auricular abscess, which may open spontaneously, or soon attract the surgeon's knife.

Unfortunately some cases do not follow any of the benign courses sketched, but proceed in a most malignant and dangerous way. The tissues behind the ear and upon the side of the neck swell more and more; the skin becomes deep red, shining and œdematous; the parts feel doughy, have a false fluctuation on deep pressure, owing to dropsy of the cellular tissue, and the auricle is pushed out from the head sometimes to a right angle.

The pain becomes very severe, especially at night; sharp paroxysmal pains shoot over the head and down the neck; the facial nerve sometimes becomes paralyzed; the affected side of the head is hot and sensitive to the touch; the eyes are restless and unnaturally brilliant; the patient feels chilly and feverish by turns, and is often covered by copious sweat; the pulse, respiration and temperature are increased; the mouth is dry and parched; there is vertigo, nausea, and sometimes vomiting; the intellect becomes clouded by day, and delirium lends its terrors to the vain attempts to sleep; thrombosis, pyæmia, meningitis or cerebral abscess may add their characteristic symptoms to the *tout ensemble*; the vital powers gradually sink; a torpor creeps over the senses; convulsions and coma follow, and death brings a blessed relief to the neglected sufferer.

These cases of atrocious suffering are most common in adults, because in children the outer shell of the mastoid is soft and thin and gives way soon, while in mature age it is hard, thick and compact, and will not yield to pressure.

The severe symptoms are caused by the ever-increasing inflammatory exudation and suppuration within the mastoid cells seeking to force a free outlet through the bone. This matter consists, in the early stages of the inflammation, of gelatinous mucus and red pulpy substance, or of muco-pus; then as the cells break down, granular matter, scales and particles of bone are found mingled with it.

There may be mild cases of mastoid disease without injury to the bony dissepiments of the process, but usually there ensues a

necrosis, ranging in severity from the destruction of a few cells, to a crumbling down of the whole bony apophysis.

The inflammatory exudation in the cellular spaces seeks and must have an outlet. It presses in every direction with ever-increasing force. This causes the frightful suffering, and constitutes the danger. Failing to perforate the mastoid outwards by carious destruction of the bone, it can pass inwards to the lateral or petrosal sinus and cause thrombosis or pyæmia, or backward and upward and produce meningitis, cerebellar or cerebral abscess.

These complications are usually fatal, and their characteristic symptoms ought to be quickly recognized, in order, to make a prognosis, and to favor an unavoidable euthanasia.

The proximity of the mastoid cells to the lateral sinus, and the emptying of the mastoid vein and other venous radicles into the sigmoid portion of this great blood channel, render the passage of inflammatory products into it an easy matter. A foreign body introduced into a bloodvessel induces coagulation of the blood and inflammation of the endothelium. Phlebitis and thrombosis are thus produced near the place of entrance, and emboli may be washed onwards by the vital fluid and set up decomposition and septicæmia, while infarcted capillaries will be surrounded by pyæmic abscesses in the area which they supply, in the brain, lungs, liver, spleen, joints, or elsewhere.

PHLEBITIS and thrombosis of the lateral sinus sometimes develop from inflammation of the middle ear, without the mastoid cells being affected, though disease of the process is the usual cause.

The characteristic symptoms are red, painful, dense infiltration, and œdematous swelling upon and behind the mastoid and down the side of the neck. There is tenderness, pain, œdema and swelling along the jugular vein; the submaxillary glands are sometimes swollen, the throat sore, and swallowing painful. Pus forms deep in the tissues, and burrows beneath the muscles and fascia of the neck, even, as low as the clavicle. The eyelids, forehead and face of the affected side sometimes become œdematous or erysipelatous; the eyeball becomes inflamed, the pupil dilated, and the optic nerve shows choked disk. Should the neck be little affected and these eye symptoms present, it would be reason-

able to suppose the phlebitis confined to one or both of the petrosal sinuses. If the lateral and petrosal sinuses are both diseased, the ocular signs ought to be markedly increased. The general symptoms of this complication would be intense pain in the side of the head, vertigo, delirium, nausea, vomiting, great restlessness, anxiety, and exhaustion.

PYÆMIA complicates most cases of phlebitis very early, so that their symptoms become mixed. The decomposed matter which has excited disease in a sinus may pass on with the blood current; other infectious particles may enter other vessels through the many channels of communication between them and the diseased centre; emboli may be broken from a thrombus and washed onwards, and the lymphatics of the ear and neck may suck up the morbid juices, and carry them down to mingle with the purple current of the vena cava.

Then shivers creep over the body; there are flashes of heat, with bright-red cheeks and hot head, followed by cold drenching sweats; there is loss of appetite, great thirst, dry tongue and mouth, an earthy jaundiced skin, and the stupor of typhoid fever. Sudden dyspnoea indicates the lodgement of an embolus in the lungs; sharp pains in the brain, liver, spleen and muscles, and the appearance of purpuric spots upon the face, neck and trunk are signs of obstructed capillaries by the emboli. The strength rapidly declines; a busy mild delirium supervenes; the pulse becomes thready; the stupor merges into coma, and death claims the sufferer.

MENINGITIS is a more frequent attendant of ear disease than phlebitis or pyæmia, and very often accompanies these complications.

Simple meningitis from ear disease, unattended by phlebitis, thrombosis and pyæmia, is much more frequent in children than in adults; probably on account of the tender sensibility of a child's nervous system, and the slight barriers between his tympanum and the dura mater covering the temporal bone. It is often a sequela of caries, and this is most common in children, who furnish the greatest percentage of scrofulous and enfeebled constitutions. Before adult life is reached, disease has decimated

their ranks, and consigned a large proportion to sleep beneath the daisies.

In nervous, bilious, and robust individuals, inflammatory products consolidate readily by the fibrin they contain, and thus tissues are covered, and channels of transmission to other parts are closed, so that disease is confined to a limited area. This is proved by the many cases of purulent middle ear disease in such constitutions, which exist for years without doing much damage to neighboring tissues. In enfeebled and strumous persons, the blood is deficient in fibrin, or the fibrin has lost its plasticity and power of fibrillation; effusions and inflammatory exudations remain liquid and gelatinous; they readily decompose, and, not only, do not close tissues and vessels against absorption, but degenerate and augment the purulent products, and increase the means and the danger of infection.

Meningitis is ushered in by rigors or convulsions; there is vertigo, irritability, restlessness, intense throbbing headache, and violent delirium; the face is alternately red and pale; there is painful sensibility to light and sound; the teeth are ground together; the eyes are red, brilliant, staring, and sometimes crossed; the pupils are contracted, and the ophthalmoscope shows choked disk or neuro-retinitis. There is full hard pulse, retracted abdomen with constipation, muscular twitchings and stiffness of the neck and limbs, considerable fever, and the *cri encephalique*.

The cerebral symptoms increase in violence, exhaustion rapidly ensues, a stupor creeps over the senses, collapse and coma supervene, and a convulsion generally marks the close of life.

CEREBRAL ABSCESS arises from purulent inflammation of the ear oftener than from any other cause. About one-third of the cases have this origin, and caries of the temporal bone frequently accompanies. Cases may occur with ear disease, but independently of it, as from a blow or injury of the skull.

The abscess may be in the pons, peduncle, cerebellum or cerebrum. A careful comparison of the physiology of the nervous system, with the neural symptoms present, may sometimes guide one to the seat of the lesion. In many cases, the seat of an abscess can only be surmised, even, when the symptoms are conclusive of the presence of one in the brain case. An abscess of large

size may exist in the brain and give few signs of its presence. A whole hemisphere has been occupied by one, yet, the victim has been able to go about his business as usual, until the sudden taking off.

The symptoms of the disease may develop slowly or suddenly. I will mention the most important. These are rigors, malaise, emaciation, nausea, vomiting, attacks of syncope; slow full pulse, intermitting or persistent; deep pain in the head, impaired intellection, dilated or immovable pupils, impaired hearing and sight, oppression, stupor, delirium, weakness of limbs; increase of earthy and alkaline phosphates, and diminution of the chlorides in the urine; paralysis of one or more cerebral nerves; hemiplegia or paraplegia; and convulsions, coma, collapse and death.

Diagnosis of mastoid disease cannot be difficult to one who has followed my description. The pain is deep, severe, and radiating; the tissues over the mastoid may be not much affected, but generally are boggy and sensitive; the discharge from a suppurating tympanum frequently ceases almost entirely with the onset of the acute complication; the constitutional disturbance is marked; the subjective symptoms are often more severe than the objective would seem to warrant. When relief from severe pain does not follow from a warm douche and a proper paracentesis of the drum-head, during an acute inflammation of the tympanum, and there is no painful inflammation of the auditory canal, one is justified in a diagnosis of mastoid disease.

Treatment.—The auditory canal should be examined and any obstruction to the outward flow of pus from the tympanum removed in all cases. A hot aural douche with the fountain syringe should be given, and Aconite tincture administered internally, a drop every hour, till relief comes, or its pathogenetic symptoms are produced. The patient should be kept warm and quiet in bed.

Capsicum has been highly extolled for early stages of mastoid disease, but I think it should only take the place of Aconite in the milder cases. Belladonna will be found frequently indicated. If the swelling is slight, wrap the side of the head with sheet cotton; if it is considerable, apply a warm flaxseed-meal poultice, and wait, especially, if the patient be young and strumous.

Some of these cases undergo resolution rapidly. It requires sound judgment to determine how long to defer surgical relief, and when it is imperatively necessary. During the period of delay, the medicines, the symptomatology of which has been already outlined, should be compared, and the newest symptoms of disease combated by them.

If the symptoms increase in violence, the redness and swelling over the mastoid augment, and the suffering becomes unbearable, do not mask it by the dangerous narcotism of Morphia or Chloral, but anæsthetize the patient, and make an incision down to the bone. This should be from half an inch to an inch and a half long, according to the thickness of the tissues, parallel to the attachment of the auricle, and over the rounded projection of the mastoid and the summit of the swelling. It should begin on a level with the upper attachment of the auricle, and extend downwards in the direction of the sterno-cleido-mastoid muscle.

The tissues are generally quite thick, and a small bistoury is almost buried before the bone is reached. Cut deep, but not below the mastoid except for an abscess. Then encourage free bleeding; compress or practice tension on the posterior auricular artery, if it happens to be cut and bleeds too freely; wash the parts clean, examine the bone, put a tent of twisted lint dipped in carbolized oil (*Acid. Carbol. gr. v., Ol. Olivæ ℥j*) in the wound, if thought necessary, and cover by a flaxseed poultice.

I do not like leeches; I think they do harm by their wounds of the skin, and the local irritation thus produced. Their action is not profound enough to influence the true seat of the disease. The incision reveals the condition of the bone, relieves tension, and diminishes the congestion without and within the process.

In case there is only a periostitis of the outer surface of the mastoid, readily recognized by the red or bluish congestion of the periosteum, and its loose attachment to the bone, or this state is united to inflammation within the cells, the diminished congestion from the bleeding, and the relief of tension from cutting through the periosteum, assisted by poulticing and the appropriate medicine may cause the disease to subside. Again, there may be a post-auricular abscess and necrosis of the outer surface of the apophysis, and a discharge of pus and pieces of bone from

the incision, and proper medication may induce cessation of the severe symptoms and recovery.

Sometimes after the abscess has been evacuated, a probe will demonstrate a carious tract, leading from the surface into the inner end of the auditory canal or the tympanum. Then the dangerous symptoms will disappear, and one should drill and scrape out the dead bone, make a free communication with the canal or ear, use antiseptic injections, and go on with the local and constitutional treatment.

The clinical reports appended to this article will throw further light upon the various phases of mastoid disease. I come now to consider those cases, where neither the incision nor any treatment sketched above will relieve the severe symptoms, which evidently depend upon inflammation within the mastoid cells.

The pent-up fluid within the bone must have an artificial outlet or it will make one, probably, inwards as already described. Nature has shown us by carious openings out through the mastoid the proper thing to do—to perforate the compact surface by knife, drill or trephine, and thus reach and liberate the imprisoned exudation. The operation is an established one, and its beneficial results beyond question, yet, as Burnett so eloquently says, "Men have been allowed to die with no better effort for their rescue, than a poultice bound over the bony cavities in which lay the cause of their dissolution."

The mastoid should be trephined in all cases in which its outer surface is intact, and the severe symptoms continue after a free incision has been made. The patient must be profoundly anesthetized. The incision having previously been made, it must be enlarged if thought necessary, and the periosteum dissected up from the bone at and around the place selected for perforating it.

The exact spot for the point of the instrument should be on a level with the upper wall of the external auditory meatus, one-quarter of an inch behind the attachment of the auricle. If the patient is young, or the mastoid is softened by disease, a firm-bladed mastoid knife may be sufficient to pierce the bone, and a probe will break a passage inwards to the antrum. In other cases Buck's trephine and drills will be found necessary.

The sides of the wound should be held apart by retractors.

The trephine should be directed inward, forward and upward against the bone, and be worked firmly and gently until a yielding is felt to the boring. Then substitute one of the drills for the trephine and proceed cautiously. In a turn or two, the cells

FIG. 80.



MASTOID KNIFE.

will be opened, and a red pulpy substance or pus escape, or, perhaps, nothing at all.

Two accidents are to be apprehended: opening the lateral sinus, if the instrument goes too low and deep, or there is a malposition

FIG. 81.



BUCK'S TREPHINE AND DRILLS.

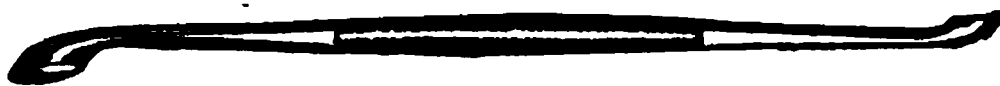
of the blood channel; opening the middle cerebral fossa and injuring the membranes of the brain, if the instrument goes too high or deep. The directions for using the instrument must be followed closely, then one will have only a malformation to fear. The lateral sinus is higher than the normal position in only two

or three per cent. of skulls, so the chances of perforating it by an operation such as described is rare.

The thickness of the compact substance of the mastoid at the point of operation averages in adult life one-fifth of an inch, but it may be much thicker, especially, if there is hyperostosis or sclerosis. In children the shell is thin, the cells small, and the process undeveloped, so that the operation is very rarely required.

After the opening has been made into the cells, whether or not there is any discharge, inject them gently with a little warm water medicated by a few drops of carbolic acid, in order to wash out inflammatory products, and to clear a free passage from the mastoid opening through the cells and middle ear to the auditory canal. Injections should be made twice a day, if there is considerable discharge from the parts. The first injection may not pass through to the ear, but the second or third probably will, and the fluid occasionally may flow through the Eustachian tube to the throat. The pressure of the water often causes pain and vertigo of transient duration; these symptoms should caution the operator to be more gentle. If inspissated pus, granular matter or particles of bone block the passage, remove them by a probe and curette, and scrape out and remove any dead bone or cell walls that obstruct the discharge. A curette that I designed and had made to order by Geo. Tiemann & Co., New York city, has proved very serviceable.

FIG. 82.



MASTOID CURETTE (half size).

Keep a tent of lint wet with carbolized oil in the wound, cover the mastoid region by a warm flaxseed poultice, stop the anæsthetic, and by keeping the room dark and silent, encourage that blessed sleep which frequently follows anæsthesia.

The patient ought to lie with the head turned toward the diseased mastoid to favor discharge; he should be protected from all physical and mental excitement, and, if cerebral symptoms do not forbid, have a comfortable dose of milk punch.

I take it for granted, that relief from the severe and dangerous

symptoms follow the operation. During the less active treatment, Cinchona, Calcareo phos., Hepar, Kali hydriod., Mercurius, and Silicea should be compared, and the most appropriate medicine for the case administered. When there are no longer any signs of osseous disease, the swelling has all subsided, the injection returns clean from the mastoid, and the middle ear disease is doing well, the opening in the bone and soft tissues should be encouraged to heal by leaving off the poultices, and applying astringent and stimulating washes.

If the operation does not bring relief from the terrible suffering, it is just to conclude, that one or more of the complications already described exists. A careful consideration of the morbid symptoms presented will probably lead to a correct diagnosis of phlebitis, pyæmia, cerebral abscess or meningitis, and a very grave prognosis.

Here, the better educated the physician, the deeper does the iron enter his soul, because of the powerlessness of medical science and art in the presence of death. He can hope against hope, and do something for his patient, even, if it be but to smooth the pathway heavenward.

Phlebitis and thrombosis modify the aural symptoms so as to require special consideration. In the early stages, Belladonna will suit the totality of symptoms admirably, and should be given in full doses of the tincture. Hepar is useful when the cerebral symptoms are mild, the tissues of the neck are boggy, and tending to suppurate; pus should be liberated by incision as soon as detected. If there is evidence of much obstruction, as shown by œdema about the face and side of the neck, Mercurius should be administered freely, on account of the plastic deposit and the accompanying neuro-retinitis. When erysipelas occurs, or typhoid symptoms become prominent, Rhus tox. tincture, a drop every hour or two, and liberal doses of milk punch may help the patient in his terrible extremity.

When pyæmia adds its symptoms to those of phlebitis, a supporting treatment by concentrated beef tea and milk punch becomes still more necessary. For internal medicines, I would rely upon Arsenicum, Arnica, Cinchona, Crotalus, Lachesis and Rhus, with an intercurrent medicine now and then for special symptoms.

The disease is blood poisoning by septic elements from the aural region. The pyæmic fermentation is analogous to those processes produced in the blood by the introduction of snake poisons, and, as it is unlikely that two fermentative processes can exist at the same time, as the vinous and acetous, for instance; it is probable that in an animal virus will be found the antidote to pyæmia. Since attempts to arrest pyæmia by other medicines generally fail, it would be proper to experiment in this direction.

Meningitis should be treated with ice-caps, and the patient kept in a quiet, dimly lighted room. Belladonna is the most useful medicine in the early stages. Bryonia is required when stupor and other signs of cerebral effusion appear, and Apis is, also, recommended. Mercurius should be given, when the severe symptoms are mitigated, as it has the reputation of being the only medicine that has cured genuine meningitis. Prof. Alfred Stillé, of the University of Pennsylvania, teaches that cases of meningitis all die; if a case recovers, he believes the diagnosis has been incorrect. This is an extreme view, because post-mortems, after death from other diseases, frequently show traces of old meningitis.

Cerebellar and cerebral abscesses are very difficult of diagnosis; when their presence is recognized, one can only follow an expectant course, as far as they are concerned, and prescribe the medicine and adopt the local treatment indicated by the totality of symptoms. Hepar, Mercurius, Phosphorus, and Silicea would seem most applicable.

In the terrible sufferings of mastoid disease and its complications, if it is found necessary to use an anodyne, I would prefer Hydrate of chloral (*Chloral hydrate*), in repeated doses of 10 grs., dissolved in Syrup of lemons (*Syrupus Limonis*), to Opium or any of its preparations. Chloral causes anæmia of the brain, and may thus lessen inflammation, while Opium produces hyperæmia and venous stagnation, which would aggravate the disease.

Caries of the Temporal Bone.—Caries is sometimes a cause, sometimes a consequence of mastoid disease, and is naturally associated with it; but because it occurs in all parts of the temporal bone, I have given it a separate article. The disease differs

at different ages, on account of variations in the development and density of the bone, and is common in childhood, rare in adult life. In a private and hospital ear practice of ten years, I have seen only about half a dozen cases in adults.

Scrofula is generally the predisposing cause, and suppuration in the tympanum the exciting one. Decomposing pus, remaining in contact with the mucous membrane of the tympanum, may cause ulceration and caries of the ossicles and of any part of the tympanic walls. Matter gains access to the mastoid cells from the middle ear, especially, in children, and remains there until the bone becomes diseased, when it escapes. Especially is this the case, when inspissated pus, a nearly intact or adherent drum-head, a polypus, an exostosis or acute swelling in the auditory canal prevent the free escape of tympanic products.

In other cases, the temporal bone fails in its nutrition, the cells break down and cause purulent inflammation beneath and in the covering mucous membrane and periosteum.

In rare instances, caries may exist in the walls of the tympanum, with the drum-head imperforate and healthy.

The disease sometimes goes on in the bone, producing hypertrophy and thickening of the overlying membranes, and sclerosis of neighboring parts. Eventually an opening occurs somewhere, and the ulceration products, consisting of pus, shreds of tissue and particles of bone, are discharged outward through the tympanum and auditory canal, through the surface of the temporal bone, or inwards to the sinuses and brain.

A rich development of granulation tissue sometimes with polypi accompanies caries, often filling the cavities with red masses bathed in pus.

Caries occurs in the walls, the roof and floor of the tympanum. In the inner wall, it sometimes sets the stapes free, converts the foramen ovale and rotundum into one large ragged hole, breaks down the loose cellular tissue around the denser bony labyrinth and forms it into one or more sequestra, and promotes their discharge outwards. The cochlea, the whole internal ear, and, indeed, the major part of the temporal bone have been removed by the ulcerative process in the osseous and soft tissues.

Of course, phlebitis, thrombosis, pyæmia, meningitis, and cere-

bellar and cerebral abscess are frequent complications of such destructive ravages.

Deafness is marked in cases where the cochlea has alone been exfoliated, and is total, when the labyrinth has become a sequestrum or has been extruded.

Caries of the posterior portion of the tympanum frequently causes paralysis of the facial nerve by pressure and neuritis; yet extensive ulceration of the bone about the nerve may exist, and the Fallopian canal lose much of its isolating walls without affecting the structure or function of the nerve.

The floor of the tympanum is rarely attacked by caries, but cases are upon record, which have resulted in ulceration into the carotid canal, and the jugular fossa, and have caused death by hemorrhage.

FIG. 83.

CARIES OF THE TEMPORAL BONE (Toynbee).

A favorite place for caries is in the lamella of bone above the tympanic membrane, between the head of the malleus and the external canal. I lately had a case of this kind in a youth of seventeen years. When he inflated the ear, a drop of muco-pus bubbled over the upper edge of the membrane, behind the short process of the malleus. A bent probe showed a very small carious cavity just above, and involving the annulus tympanicus.

The Fallopian tube and the internal auditory meatus are occasionally the seats of caries.

The horizontal cells of the undeveloped mastoid process of

infants are frequently affected by caries, and an opening takes place usually in the squamous portion of the bone, above and behind the meatus. The upper boundary of these cells, continuous with the roof of the middle ear, is quite thin and prone to ulceration, which frequently causes meningitis and cerebral abscess.

Another favorite carious outlet is forward through the inner portion of the posterior wall of the auditory canal. The bony wall of the canal yields, pus bursts the dermic covering and runs out of the external meatus, leading one to believe it comes from ordinary suppuration of the tympanum.

The mastoid process of adults, consisting of rows of horizontal cells above and vertical cells below, becomes carious from acute inflammation within the cells, from the slow imperfect subacute inflammation of scrofula or tuberculosis, and from periostitis of the outer surface. Portions of the bone are surrounded or cut off from nutrition by the ulcerative process; they become necrosed and form sequestra, which undergo slow absorption, or are discharged through sinuses or abscesses.

The size and shape of sequestra will sometimes indicate their origin. When the outer compact tissue will not yield, the carious process with its pus and débris may work in other directions, and produce one or more of the terrible complications mentioned under mastoid disease.

The bone sometimes undergoes caseous degeneration, and though presenting the outward form, is easily cut; the caries may continue for a long time, and the bone gradually shrink from molecular disintegration; or a sequestrum may be isolated and discharged, and recovery follow rapidly.

Repair begins by granulations filling up the cavities; these develop into cicatricial connective tissue, which gradually changes into dense eburnated osseous structure by deposition of lime-salts, and a depression remains in the bone, if the opening has been outward. Sometimes the channels and cavities formed by the disease persist, and become lined by a smooth non-secreting membrane, resembling an ingrowth of skin such as is seen in the tympanum of some cured cases of purulent inflammation.

The symptoms of caries of the temporal bone vary with the part attacked, and some of them have been enumerated in the foregoing paragraphs. In most cases, purulent inflammation of

the tympanum is present and masks the mild caries within the tympanum or external canal. Caries of the inner tympanic wall has been recognized through a healthy and imperforate membrana tympani.

If the seat of the disease can be seen, one will notice an ulceration, bordered by raised edges and large granulations. A probe passed over the base of the ulcer, or pushed into a fistula that may open into it, will transmit the rough, grating feeling of diseased bone. When the locality of the lesion is suspected, but cannot be seen, a probe bent at different angles may be gently applied to various parts in exploration. Probing in the tympanum is delicate business, and should only be attempted under good illumination by one who knows the dangers.

The discharge from carious bone is brown and offensive, and it contains little dark osseous particles, which may be recognized by the microscope.

In coarse caries, ulceration, fistula, and abscess, the easily felt crepitation of the probe upon the bone, and, perhaps, the presence of a movable sequestrum are pathognomonic symptoms.

There is some fever and evidence of constitutional irritation in most cases of caries. The cheeks show red in surrounding paleness; the side of the head is hot; chilliness, flushes of heat, and copious sweats alternate; the mind is peevish, and sleep uneasy. A slight pain or deep heavy aching is felt in the aural region; deafness in some degree exists; tinnitus, throbbing, and vertigo may occur; the mastoid process and auditory canal becomes red, tender and oedematous; and to these may be added any of the grave symptoms mentioned under mastoid disease and its complications.

The prognosis will depend upon the age of the patient, and the situation and extent of the caries. Children often throw off large pieces of necrosed bone, and have the disease for a long time, yet, finally recover.

Adults die from less. They are more liable to complications. The deeper the caries extends into the bone, the greater the danger to audition and life. The outlook is always unpromising, and a guarded opinion should be given.

Treatment.—In all cases of this disease, early and constant treatment is imperatively demanded. Though caries sometimes

occurs in the temporal bone primarily without any disease of the ear, and, again, during the proper treatment of an aural affection, as already mentioned; a large majority of the cases arise from chronic purulent inflammation of the tympanum, which has not been treated at all, or in such a slipshod manner as to have had little effect in checking the disease.

The auditory canal should be cleared of all obstructions; sinuses enlarged, if necessary, and emptied of inspissated pus and débris of osseous tissue; the membrana tympani incised freely, if it is retaining inflammatory products in the tympanum or mastoid cells; large granulations and polypi twisted off or evulsed; abscesses lanced and evacuated, and movable sequestra gently removed. A douche of warm carbolized water should be directed into the auditory canal, sinuses, and carious cavities of the bone, until every particle of matter, blood or loose osseous tissue is washed away.

When the seat of caries can be reached, and the anatomical relations do not forbid, the dead bone should be scraped away by the mastoid curette, until the healthy bone is reached. Small spots of caries upon the wall of the tympanum and in the canal, treated in this manner, and then touched with a little pure carbolic acid, granulate and close readily. When there is caries of the surface of the mastoid, with a sinus inward or forward, a free opening should be maintained through the soft tissues, the dead bone scraped out as much as is considered safe, and a probe passed cautiously in different directions towards the tympanum, and the bony portion of the external canal. In most cases, the sinus will be found to communicate with one or the other of these, generally, the latter, and movement of the probe will enlarge it somewhat, so that the inflammatory waste may be washed both ways, and the parts thoroughly cleaned.

If the posterior wall of the osseous portion of the canal is red and tender, and a probe introduced into a carious mastoid leads nearly to this surface, I think it would be advisable to break down the thin barrier, in order to facilitate thorough cleansing, promote easy elimination of morbid products, and diminish the danger of extension of the caries inward and upward.

A flaxseed poultice ought to be kept upon the mastoid, and a piece of absorbent cotton in the auditory meatus, but syringing

and wiping with wisps of cotton must be done often enough to prevent any considerable accumulation of pus. As improvement of the local condition ensues, I substitute for the carbolized water, a mixture of one teaspoonful of Tar tincture to half a cupful of water, and inject this freely into the diseased places. This is antiseptic and stimulating.

With the dead bone scraped away ; sequestra removed by gentle traction, and an incision made, if necessary ; the parts cleansed and disinfected daily ; appropriate medicines prescribed ; and the general health improved, the patient is tolerably safe, and recovery may be expected sooner or later. Of course, disease of the middle ear if present is to be treated according to directions already given, and the special measures made necessary by disease of the osseous surroundings are to be supplementary. What has been presented under complications of mastoid disease applies with equal force to caries, because the former is both cause and consequence of the latter.

Meningitis and pyæmia are more frequently seen as a result of caries, than the other affections mentioned. The principles of treatment have been already formulated.

Patients suffering from caries should be well clothed, fed, and housed, just what many poor children cannot get. Frequent salt baths, woollen underclothes, and a dry residence ; a strong diet of oatmeal, corn and wheat bread, milk, eggs, and meat, with two or three doses of cod-liver oil (*Oleum Morrhuæ*) a day ; persistent and conscientious local treatment, and the administration of indicated remedies, will in most cases bring about a cure.

Arsenicum, Belladonna, Cinchona, Calcareæ phos., Ferrum iod., Hepar, Mercurius, Nitric acid, Rhus tox., and Silicea are the most appropriate medicines for the conditions one is called upon to treat, but unusual phases of the disease may demand others. The reader is referred to the medicines mentioned under chronic purulent inflammation of the tympanum for their leading characteristics.

I present a few typical cases from my practice, illustrative of caries and mastoid disease.

CASE I.—A girl thirteen years of age, blonde, thin, pale, and anæmic, was brought to my Eye and Ear Clinic at the Children's

Hospital, Philadelphia, though she was hardly fit to be out of bed. She had suffered from severe scarlatina a year before, during the course of which an acute inflammation of the middle ear had developed, causing rupture of the tympanic membrane and a flow of pus, which had continued until three days before. She had then taken cold, and had pain in the right ear, with lateral headache and fever. The next day she was better, but a swelling was noticed behind the auricle. The mother stated that, the night before I saw her, the patient complained much of pain about the ear and side of the head; was very sensitive to noise and light, feverish, restless, and slightly delirious. She had staggered when she got up in the morning, and had later vomited some of her breakfast.

I found the patient's pulse, respiration and temperature increased; she shrank from bright light, said noises hurt her head, staggered a little in walking, and complained that the whole side of her head hurt her dreadfully.

The external auditory meatus was filled with decomposing pus and large granulations, and the auricle stood off from the side of the head, owing to a fluctuating swelling the size of a pullet's egg over the mastoid. The whole aural region was exquisitely sensitive, and when I injected warm water gently into the ear, she almost fell off the chair. Here was a condition of cerebral hyperæmia bordering upon meningitis, dependent upon confined pus and mastoid disease.

I etherized the patient, extracted a bunch of polypi from the tympanum, then made a long incision over the mastoid, and liberated over half an ounce of pus. This was my first case of mastoid disease and I was somewhat anxious about it. The tissues around the abscess were thick and boggy, and after I had evacuated the pus, the thin incised portion sank in to such a degree, that I feared the whole mastoid was gone, and I had opened into the brain case. Cautious exploration with the forefinger soon revealed the state of the case, and restored my equanimity. There was a perforation in the surface of the mastoid, its cells were carious and broken, and I passed a probe inward and forward until it entered the inner portion of the auditory canal, and clicked against another introduced through the meatus. Warm

carbolyzed water was injected into the mastoid opening and out of the meatus, a tent of twisted lint was pushed into the incision, a flaxseed poultice ordered applied, and Kali brom. gr. v, dissolved in water, given every three hours.

The next day I visited the patient at her home, and found her relieved from her sufferings and dangerous symptoms. The local treatment was continued, and cod-liver oil ordered. She came to the clinic after a few days, and through systematic local and constitutional treatment the discharge declined and finally ceased, the sinuses healed, the middle ear disease yielded, and her health became fully restored.

CASE II.—A girl, eight years old, had chronic purulent inflammation of the tympanum, a sequela of scarlatina, for eight months. One day the discharge from the meatus ceased, severe pain in and about the ear ensued, and she was brought to the hospital for treatment.

I extracted a fragment of bone from the external canal the size of a small bean, evidently a piece of the cellular mastoid, found the posterior canal wall carious, scraped out a few scales of bone, and injected warm carbolyzed water. After several weeks treatment of the caries and the coexisting purulent otitis, and improvement of the general health, the patient entirely recovered.

CASE III.—Another girl, aged nine years, thin, anæmic and scrofulous, had scarlatina and chronic purulent otitis. The unhealthy pus literally streamed from her ear. I never saw so copious a discharge from the meatus.

The family doctor had told the mother the patient would outgrow the disease, and it would be dangerous to interfere. A painful swelling had appeared over the mastoid process, which led to her consulting me.

I found a post-auricular abscess, cut down, evacuated the pus, and removed the whole outer shell of the mastoid process, which was loose and necrosed. The patient was much improved by the treatment adopted, but ceased her visits after four months.

CASE IV.—A boy, nine years old, of lymphatic temperament had a light attack of measles and a concurrent otitis media, which resulted in perforation of the tympanic membrane and a purulent discharge. The patient was scrofulous, the ear affection fell into

the chronic stage, and fetid pus flowed from the meatus in moderate quantity continually. He had several acute exacerbations, during one of which the mastoid tissues became swollen, formed an abscess, and opened spontaneously behind the auricle. The opening had persisted, and from it came a moderate discharge. In several subsequent acute exacerbations, he had suffered severely from lateral headache and cerebral excitement, and upon one occasion he became delirious, and so ill that his life was despaired of, and his physician, *who had been treating him a year with nothing but powders internally*, remained in almost constant attendance for three days.

It was during another severe attack that I was called to his aid. I found the boy in high fever, with severe lateral and frontal headache, and some delirium. There was very little discharge from the mastoid sinus or the meatus; the mastoid was swollen and tender, and a huge mucous polypus almost entirely occluded the auditory meatus. I removed the polypus, touched its base with Nitric acid, enlarged the opening behind the ear, extracted several pieces of dead bone, injected a warm antiseptic solution through the mastoid and out of the meatus, and gave Belladonna tincture in water.

The relief was almost magical, and, the next day, I found my patient playing around the room entirely free from pain. I cleaned the ear and mastoid daily, ordered injections of a solution of Sulpho carbolate of zinc (*Zinci sulpho-carbolas gr. x, Aqua f3j*), three times a day. In four days, the mastoid sinus had healed, and only a slight show of pus flowed from the meatus.

The local treatment of the middle ear was continued, varying the astringent injection somewhat, Calcareo carb. was given internally, and, in six weeks, the patient was discharged cured, and able to hear the watch two inches.

CASE V.—A boy, thirteen years of age, of nervo-fibrous temperament, had suffered four years from chronic purulent inflammation of the tympanum, a sequela of diphtheritic pharyngitis. His health was good and the discharge from the ear slight. He had been under homœopathic treatment in the early period, and latterly under none. He had taken cold, and had severe tonsillitis and great pain in the ear and mastoid. I found a little

discharge from the ear, and a polypus in the tympanum, extending into the canal. I twisted this off with forceps, ordered hot-water injections, and gave Aconite tincture in water. The next day the pain about the mastoid was severe, there was less discharge from the ear, and considerable fever. The medicine was continued, and a poultice applied to the post-auricular region. The next morning the patient was doing well, but towards evening he became much worse. The discharge had not increased; the mastoid region was swollen, hard and sensitive; there was severe lateral headache, vertigo, and hyperæsthesia to sound and light.

I considered action imperative, anæsthetized the patient, cut down upon the mastoid, and, using a small trephine soon made a hole into its cells, and liberated about half a teaspoonful of pus. A clear channel was made by a probe through broken-down bone cells into the tympanum, and the usual treatment instituted. The pain and threatening symptoms disappeared under Kali bromidum; Cod-liver oil, Cinchona and Ferrum iod. were given internally later; the mastoid wound healed rapidly, and the discharge was arrested by nitrate of silver, and alum injections, in about two months, when he was dismissed cured. During two years that I watched this case, the ear gave no further trouble.

CHAPTER VIII.

CHRONIC INFLAMMATION OF THE EUSTACHIAN TUBE AND TYMPANUM.

I HAVE, in another chapter, united acute catarrhal and acute purulent inflammation of the tympanum, considering it inadvisable for practical purposes, to separate two phases of an inflammation, that differ so little in symptoms, course, and treatment.

I shall consider chronic catarrhal inflammation of the Eustachian tube, and of the tympanum, and the so-called proliferous inflammation, under the above caption, believing of the first two, that each is both cause and consequence of the other, and that the last is a late pathological change depending upon them.

Catarrhal Inflammation of the Tube and Tympanum.—This common disease is characterized by considerable sero-mucus discharge from the mucous membrane of the Eustachian tube and middle ear, with more or less disease in the naso-pharyngeal space and throat. At least one-half the diseases of the ear that apply for treatment are of this kind, and unfortunately most of the patients do not realize their condition, nor seek medical aid, until the pathological process is far advanced, and the delicate auditory apparatus is seriously injured. The disease has become chronic, fixed, and progressive, perhaps, without ever having been acute; either having had no treatment, or the coddling, inefficient, unscientific measures recommended by gossiping neighbors and careless physicians.

Persons with normal ears can hear a common watch five or six feet. They can hear ordinary conversation, when the auditory power has diminished so that they can only hear the same watch four to six inches. As most of the sounds essential for one to hear are as loud as medium voice, and concentrated attention will improve audition in some degree, patients, who have lost the power of hearing the watch at various distances between four inches and six feet, will not generally be conscious of their defects

until accident or a comparative test reveals them. Dr. Roosa has very happily called this "superfluous hearing," and says, "people who spend many hours of the day in noisy places may lose very much of their hearing power before they are aware of it."

Every aurist knows, that many persons, who do not consider themselves deaf at all, cannot hear a watch at a foot distance. A gentleman brought his wife to me for treatment of a purulent otitis, and said his own hearing was excellent. I tested his ears and found R. E. Hw. $\frac{1}{8}$ $\frac{5}{8}$, L. E. Hw. $\frac{1}{8}$ $\frac{0}{8}$; thus showing a decline in audition due to the disease about which I am writing. This is only one of many such incidents, that have occurred in my personal experience.

Among the predisposing causes of this disease, the most prominent is a catarrhal diathesis. This I have found more common in strumous persons, with light hair, blue eyes, thin skin, and delicate mucous membranes; but the dark types of scrofula furnish many cases, and rheumatic and gouty persons have a portion. The inveterate and disappointing cases, those in which treatment long continued and scientifically applied has very little effect in arresting the profuse discharge, though the hearing may be improved a little, are in lymphatic and scrofulous constitutions. Rheumatic and gouty persons are not so liable to excessive discharges, but it is a question whether this is not counterbalanced by their tendencies to hypertrophy, hyperplasia, and calcification. These constitutional diatheses are transmitted from generation to generation, and thus heredity must be mentioned as a predisposing cause. I have had histories of deafness in three generations of a family and treated members of the last two. The diathesis was arthritic and the temperament bilious.

Youths and middle-aged persons are more often afflicted by catarrh than the aged, who present the greater number of proliferative cases. In my experience, the female sex has furnished more cases of both varieties of the disease than the male, but this may be because females seek the doctor for every ailment quicker and oftener than males do.

An enfeebled state of the body from the presence of disease, for instance, chlorosis, leucocythæmia, asthma, tuberculosis and

syphilis, or following any severe affection, such as diphtheria, the exanthemata, and continuous and malarial fevers, predisposes to chronic throat and ear diseases.

Defective personal hygiene; neglect of baths; insufficient clothing; badly ventilated, cold, damp homes; exposure in occupation to drafts, strong winds, and wettings; irregular hours and dissipation; contracted nasal fossæ, necessitating breathing with the mouth open, may all be mentioned as predisposing causes.

The exciting causes are multiple; they include many of those which produce acute inflammation in the region, and others slower but not less certain in their action.

Some of these affect the ear apparently through the external auditory canal and membrana tympani, and extend secondarily to the Eustachian tube; others act upon the nose, pharynx and throat, and produce inflammation of the Eustachian tube, which shuts off the air from the tympanum, and thus inaugurates a morbid process therein, or which creeps along the mucous membrane till it reaches and involves the lining of the middle ear and mastoid cells.

I will first enumerate those causes, which have appeared to me to affect the ear primarily through the membrane. Getting water in the canal from careless washing; dipping the head under water, particularly after being heated; wetting the hair frequently to make it lay well after combing; cutting the hair close in cold weather; covering the ears with the hair at one time, and leaving them exposed at another; stuffing the auditory canal habitually with cotton; an accumulation of cerumen and dirt from an excess of hairs in the meatus; scratching, scraping and digging in the ears to relieve itching and to remove cerumen; spending many hours daily in noisy workshops and mills; an attack of mumps; eczema of the canal and membrane; furuncles and abscesses in the canal; foreign bodies in the canal; mechanical injury of the drum-head, and medicinal solutions dropped in the ear for ear-ache from neuralgia of the trifacial nerve.

Other causes, connected with morbid states of the nose, pharynx, and throat, excite inflammation in the Eustachian tube, which extends quickly into the tympanum, as in coryza, hay fever, etc., or creeps slowly along the mucous membrane into the

cavity. It shuts off the air from the tympanum frequently, and thus inaugurates a subacute inflammation in its mucous membrane.

Coryza, influenza, and hay fever begin by acute inflammation of the nasal mucous membrane, which generally extends into the pharynx, and frequently involves the lining of the Eustachian tube and tympanum.

The Schneiderian membrane tingles as if bathed in weak ammonia; sneezing is frequent; there is a dry stuffed feeling in the nose and frontal sinuses from congestion; clear serum soon begins to flow from the nose, and handkerchiefs are saturated rapidly; there is diminution of smell and taste; a nasal tone to the voice, and some febrile reaction. When the trouble reaches further, the throat is a little sore, there is frequent swallowing to remove discomfort and a feeling of tension at the mouths of the Eustachian tubes. The inflammation may affect the tubes, fill their lumen and the tympanum with mucus, cause dulness of hearing and râles on inflation, and, perhaps, some pain through the aural region.

This condition may develop acute inflammation of the tympanum, as before mentioned, but is more likely to subside, leaving traces of the storm along the mucous tract. Other attacks come to augment the mischief, and chronic disease becomes firmly seated in the tissues of the tube and tympanum, as well as in the nose and pharynx.

The mucous membrane of the nose during the acute stage is moist, red, velvety, and tumefied. Glistening serum and small patches of adhesive mucus cover the surfaces, and the swelling often prevents nasal respiration, and hides the depressions and scrolls of the turbinated bones.

Acute Pharyngitis arises often from the same causes as coryza, and frequently complicates it. It is an inflammation of the mucous membrane of the buccal pharynx, generally involving the naso-pharynx, the soft palate, and the pillars of the fauces, and frequently extends to the larynx. It is usually a common sore throat from taking cold, but may be a local manifestation of erysipelas, diphtheria, measles, scarlatina, small-pox or syphilis.

It is preceded by malaise and depression of spirits, and is ushered in by a chill; fever follows, and the throat symptoms soon become decided. The throat itches, and feels dry, rough, swollen, and painful; swallowing causes more or less sore and sharp darting pain in the throat, often extending to the ear and down the side of the neck; the throat outside is sensitive, sometimes swollen, and some of the submaxillary glands are engorged and tender.

Inspection of the throat reveals deep redness, congestion and swelling of the mucous membrane; the uvula is often oedematous and elongated; the tonsils more or less swollen, and the epiglottis thickened and rigid.

If the laryngeal mirror be used, the naso-pharynx, posterior nares and larynx will be found frequently to participate in the mucous inflammation. If the nose is affected, nasal respiration will be interfered with, the sense of smell and taste blunted, the voice altered, and some other symptoms of coryza present.

The Eustachian tube and middle ear are frequently affected by the disease; then there is fulness, tinnitus, deafness, mucous râles, and pain shooting along the tube to the ear.

In simple cases, the hyperæmia and swelling of the region soon cause increased secretion; there is a copious discharge of serum from the dilated vessels, and of mucus from the irritated follicles; the swelling gradually melts away, and the throat returns to a normal condition, or, here and there, traces of the attack may remain in patches of thickened or atrophied mucous membrane, enlarged follicles, hypertrophied tonsils, and subacute catarrh of the Eustachian tube and tympanum.

Whenever pharyngitis has a specific cause, such as diphtheria, syphilis or an exanthematous disease, the symptoms are severe, prolonged, and modified by the particular affection coexisting. Then great injury to structure and functions ensues, and the auditory apparatus frequently suffers severely.

Ulceration, abscess, sloughing, and gangrene in the naso-pharynx and throat destroy and distort the tissues, and are followed by cicatricial adhesions and contractions, which interfere with or prevent the normal action of the muscles of the pharynx and palate.

I have had two patients with a permanent round perforation, the diameter of a lead-pencil, through the velum between the uvula and tonsil, resulting from scarlatina. Several others have had mutilated soft palates, with portions firmly attached to the posterior and lateral walls of the pharynx. Some were caused by scarlatina, others by diphtheria.

Syphilis causes frightful ravages in the soft and hard palate, pharynx and larynx. The worst case I have ever seen came to the Pittsburgh Hospital for treatment. The palatine process of the superior maxillary, the palate bones and vomer, with their soft tissues, were completely destroyed by syphilis, leaving a yawning cavern behind the alveolar arch and nasal cartilages up to the base of the skull, in which one could have buried a fist. The mouths of the Eustachian tubes could be plainly seen; the pharyngeal mucous membrane was thickened and granular, and the tubes and tympana were in an advanced stage of chronic catarrhal inflammation.

Besides the acute and chronic inflammations excited in the Eustachian tube by the pathological conditions mentioned above, cicatricial closure of the Eustachian tube occurs occasionally from ulceration of the pharyngeal opening or of the pharynx immediately surrounding it. It is seen, also, within the tube, and is said by Schwartze to be frequent at the tympanic end, owing to caries of the temporal bone.

Chronic Nasal Catarrh is usually accompanied by chronic inflammation of the naso-pharynx and pharyngeal tonsil. It results from repeated attacks of coryza, or cold in the head, and becomes a serious disease, when the subject is strumous or syphilitic.

The nose and pharynx feel alternately dry and moist; dry when indoors and in a warm atmosphere, moist and discharging sero-mucus when in the cold. The nose becomes stopped in some patients during the night, or is occluded all the time by swellings, scabs and crusts; respiration takes places through the mouth, and the throat becomes dry and rough.

In the morning, there is usually a clearing spell; blowing anterior, taking strong inspirations, and hawking out muco-pus

from the naso-pharynx. The frontal sinuses feel full, the forehead and eyes strained and uncomfortable; the lachrymal canals are sometimes obstructed, and the eyes water; the eyelids often twitch, taste and smell are blunted, the respired air has a disagreeable odor, the voice has a nasal sound, and attempts to speak long or to sing, are sometimes interrupted by fetid mucus dropping from the posterior nares into the throat.

There is generally a slow procession of stringy mucus down the posterior pharyngeal wall; and in severe cases, called *ozæna*, blood and foul masses of inspissated muco-pus and crusts, shaped into casts of the cavity, where they have been retained and have degenerated, appear in the throat and are removed by the finger or pass down into the stomach.

The nasal and pharyngeal mucous membrane, in mild cases of chronic catarrh, is deep red; the epithelium is succulent and granular; the submucous tissue infiltrated, hypertrophied, and oedematous. In other cases, this hypertrophy is accompanied by atrophy; the epithelium has disappeared in places; the membrane is pinkish, thin and closely adherent to the cartilage and bones; finally, the nasal passages become enlarged from atrophy of the mucous membrane and spongy bones. Ulcers are seen here and there; mucus, pus, and disgusting brownish-green crusts cling to the depressions; the expired air is sickening in odor, and in some cases the disease is contagious. Patients should be cautioned not to let other persons use their toilet articles.

When there is a vitiated constitution, the ulceration may go deeper, the bones become carious, and frightful ravages occur in the palate, nose and face. The naso-pharyngeal mucous membrane is in sympathy with the morbid states of the nasal fossæ; it presents the same hypertrophy, atrophy and ulceration as are seen in the nose, and its disease is aggravated by the foul discharge that is almost constantly in contact with it, being greatly augmented by hypersecretion of the pharyngeal tonsil. This sheet of spongy glandular tissue is in some of these cases swollen to an inch in thickness, and, not only, furnishes considerable secretion, but, also, obstructs in a measure the posterior nares, and, even, the mouths of the Eustachian tubes. These latter are

certain to become affected by the pharyngeal complication, if not by obstruction, and thus tubal and tympanic disorders originate.

Polypus of the nose and naso-pharynx occasionally arises *de novo*, or as an accompaniment of catarrhal inflammation. In nasal catarrh, the covering of the turbinated bones sometimes becomes so dropsical, as to project and much resemble a mucous polypus. Mucous cysts filled with fluid or glandular secretion are seen occasionally in the nose. Mucous and fibroid polypi spring from the mucous membrane, and are more frequently located in the posterior portion of the nasal fossæ than elsewhere. True polypi arise rarely from the wall of the pharynx.

The first symptom to attract attention is frequent snuffing to free the inferior meatuses from a stuffed feeling; later, greater obstruction is felt on damp days, owing to greater swelling, and finally to total occlusion from increased growth. There is a mucous discharge sometimes mixed with blood from the anterior and posterior nares; the respiration is partially by the mouth, which dries the pharynx and induces disorder; asthmatic symptoms are not infrequent; the voice has a nasal tone, and some deafness is noticeable.

The mucous tumors are bright red, smooth, soft, elastic and succulent. They vary from the size of a grain of rice to that of the fist, generally occur in groups, are usually knob-like or pedunculated in shape, readily insinuate themselves into depressions and cavities, and sometimes prove dangerous to life.

The fibrous polypi are pinkish, smooth or tuberculated, of firm consistency and moderate size. They do not swell in damp weather, but grow slowly, and are generally solitary. They spring from the submucous tissue, are very firmly attached to the cartilage or bone, difficult to remove entirely, and, therefore, prone to relapse.

Polypi may be diagnosed by dilating the anterior nares with Frankel's speculum, by the laryngeal mirror behind the palate, and by palpation with probe and index finger. Fortunately other tumors are rare in this region, but enchondromas, sarcomas, and carcinomas have been encountered.

Polypi may be the cause or consequence of chronic catarrh of the

nose and pharynx, and this is prone to affect the integrity of the Eustachian tube, if the mechanical irritation from the presence of a polypus near or against the opening of the tube does not. In total obstruction of the nose, the air does not find ready access to the tympanum, rarefaction of the air therein occurs, and ear disease is excited.

Adenoid Tumors are benign growths, which arise in the upper pharynx of persons of a lymphatic temperament, owing to hypertrophy of the pharyngeal tonsil. This organ consists of a sheet of glandular tissue, which extends from one Eustachian tube to the other, over the sides, back and vault of the pharynx, and these tumors spring from its stroma. They vary in size from mere granulations, to thickenings and growths that fill the vault and totally obstruct the posterior nares. When located upon the lateral walls, they are disk-like and sessile, but in the roof are conical, leaf-like, flask shaped, and pedunculated.

They consist of a net of fibrous tissue filled with lymph cells and many vessels; are covered with cylindrical epithelium, mostly ciliated, and bleed easily when touched by the finger or an instrument.

The presence of these tumors causes mechanical irritation, congestion and catarrh of the nose, pharynx, and Eustachian tube; there is a copious secretion of greenish-yellow mucus; diminished smell and taste; a smothered tone of voice; a stopped feeling in the ears with deafness; obstruction of the nose, with breathing through the mouth; snoring at night; dryness and discomfort of the throat; sometimes enlarged tonsils, and a pinched, stupid expression of countenance, owing to falling inwards of the nose, and the almost constantly open mouth.

These tumors are not so common in this country as in Europe. They are seen in childhood and youth more frequently than in adults, and are thought to disappear spontaneously very often, as age advances. The disorders which they excite in neighboring parts render it necessary to treat them early and actively.

Dr. Loewenberg, in his monograph, *Les Tumeurs Adénoïdes du Pharynx Nasal*, says: “*Nous croyons de notre devoir d'appeler l'attention générale sur cette maladie, d'autant plus qu'elle se rencontre*

très-fréquemment et que, malgré l'ensemble très-frappant des symptômes causés par la présence des tumeurs adénoïdes pharyngiennes, les véritables causes du mal sont généralement cherchées ailleurs, au grand détriment du malade, ainsi que nous l'avons constaté maintes et maintes fois."

The diagnosis may be tolerably certain from the symptoms enumerated, but should always be confirmed by ocular inspection with the laryngeal mirror, and by palpation with the probe, catheter and fingers.

Besides the danger to hearing from extension of the inflammation of the mucous membrane of the pharynx to that of the Eustachian tube, and from occasional obstruction of the tube by proximity of a tumor, occlusion of the nose prevents proper aeration of the tympanum, and thus causes what may be called a disease *in vacuo*. This has no necessary connection with the cause of obstruction, which may be from chronic catarrhal inflammation, polypus or adenoma indifferently. The subject is so important, that I give an outline of its mechanism and genesis.

In the act of swallowing, the palato-pharyngeal folds and the soft palate are drawn backward and upward against the posterior wall of the pharynx, and shut off the naso-pharynx from the throat. In a normal state of the parts, the air above the palate is somewhat compressed, and rushes into the Eustachian tubes which are opened by deglutition, and into the nasal fossæ, while some of the air below goes into the stomach. As the veil of the palate falls down to its usual pendulous position, though this action is somewhat limited by spastic contraction in old cases, a slight rarefaction of the air is produced above it, and air passes in through the nose and sometimes through the mouth to restore the equilibrium. The action of the palate and posterior pillars of the fauces can be readily seen during gagging.

Now when the nose is stopped and the air supply is cut off anterior, the backward and upward movement of the posterior pillars and soft palate compresses the air in the naso-pharynx, generally diminished in size from disease, and, as the palate falls, a greater rarefaction occurs than in the normal state, because no air can come through the nose, and this is increased greatly by the attenuation of the air in the throat produced by swallowing.

As all gases follow the law of diffusion, the denser air is sucked instantaneously out of the tympanum to restore equilibrium, and the Eustachian tube closes. The rarefaction in the throat is only momentary, because air rushes up from the lungs and in at the mouth, which is generally opened immediately after swallowing to relieve the sense of suffocation, caused by suspension of respiration, even, the few seconds required for swallowing—but *the Eustachian tube remains closed and the tympanic air rarefied.*

Every one is familiar with the fact, that air of moderate density opens the Eustachian tubes and escapes easily, but rarefied air cannot, while it requires considerable condensation to open the tubes and inflate the ear by the Valsalvian method. The air in the tympanum therefore remains rarefied, unless the ear is inflated artificially, because the pressure of ordinary air cannot open the Eustachian tube, and every act of swallowing renews the rarefaction, if it does not increase it. As a result of this, the tympanic membrane is pushed inward by the greater pressure of air upon its external surface, and the tympanum is prepared for a morbid process. Thus an occluded nose may alone excite various diseases of the middle ear.

Enlarged Tonsils.—Acute inflammation of the tonsils demands no other consideration from me, than that given under acute pharyngitis. Chronic inflammation, or hypertrophy, of the tonsils, was thought formerly to be a direct cause of deafness, by inducing mechanical pressure upon the Eustachian tubes. More exact clinical observation has demonstrated this to be an error, and has proved ear diseases in connection with tonsillar hypertrophy to depend generally upon morbid states of the pharynx. Löwenberg believes that many cases of deafness, reported as caused by enlarged tonsils, were in reality due to adenoid tumors in the naso-pharynx.

Enlarged tonsils rarely exist without some disease of the pharynx, which may be secondary on account of the irritation caused by the glandular hyperplasia pushing the posterior pillars of the fauces backward and upward, and, also, by its curving around the velum into the naso-pharynx, as I have seen in some instances. In most cases, the picture presented clinically is one of

chronic pharyngitis and enlarged tonsils, and it is unimportant and often impossible to say which has been the primary affection.

Enlarged tonsils cause difficulty of swallowing, thick imperfect articulation, inability to utter high tones, occasional hoarseness, noisy respiration especially at night, sometimes a tickling cough, and frequent hawking and clearing the throat of thick mucus. The tonsil is rough, uneven, tuberculated and pale or red; it has light streaks of cicatricial and hypertrophied connective tissue; the follicles are deep and dark between the protuberances, or show as white spots of caseous secretion and sometimes ulceration. This condition of the gland renders it liable to acute exacerbations of inflammation upon slight exposure which still further increase the organ.

Children are more subject to this disease than adults, and in rare cases, enlarged tonsils shrink with the establishment of puberty.

When a tonsil has reached a size which makes it interfere with the physiological action of the palate, throat and larynx, it should be reduced by medicines or by a surgical operation.

Chronic Pharyngitis.—Immediately following the redness, congestion and swelling of the pharyngeal mucous membrane from acute disease, or developing slowly as the result of irritation, exposure, and bad treatment, the pharynx presents several varieties of chronic inflammation, which must be differentiated in order to treat them rationally. They are distinguished from each other by their objective, rather than their subjective symptoms, and though the varieties run into each other, the appearances are sufficiently distinct to warrant separate consideration.

Besides the causes of chronic pharyngitis found in diseases of the nasal fossæ, naso-pharynx and throat, from general or specific influences, there are some others worth mentioning. The pharynx is admirably situated to catch the particles of dust and dirt that pass through the nares, as well, as those that enter the throat during temporary or permanent respiration through the mouth. In atmospheres loaded with inorganic and organic matter, the mucous membrane of its posterior wall is kept in a state of constant irritation.

Millions of microbia, monads, bacteria, rhizopods, spores of fungi, grains of pollen, whole algæ, organic débris, and mineral particles are seen in the air we breathe; is it any wonder that the pharynx should become diseased, when currents of air loaded with this matter enter by the mouth, and make such deposits upon the tender epithelium?

Buccal respiration has a very deleterious influence upon the pharynx. When air enters the lungs by way of the mouth, it cools the mucous membrane of the throat, except in exceptionally high external temperatures, and abstracts moisture from it, so that dryness and roughness are felt in swallowing, and inflammation soon ensues.

Taking iced drinks and ices in excess, and often in alternation with hot beverages and food; for instance, ice water or iced tea at dinner, ice cream followed by hot coffee, etc., as seen frequently among intelligent people, and even in physicians' families, excites chronic disease of the throat.

In my opinion it is what goes down the throat, and not gas, regurgitated food, and sympathy, that produces the so-called gastric pharyngitis. Drinking spirituous liquors undiluted; swallowing accidentally hot or corrosive liquids; using spices in excess; smoking and chewing tobacco; breathing dry stove, furnace, and foul air; exerting the voice greatly in singing and public speaking; all these, cause irritation of the pharynx, and various degrees of inflammation.

Pharyngitis presents three well-marked phases, which I shall designate as the hypertrophic, atrophic, and granular.

Hypertrophic Pharyngitis has fulness and roughness of the throat, a sensation that excites to frequent hawking or swallowing to ease the parts; coughing, gagging and expectoration of considerable whitish-yellow mucus; occasional soreness after exposure and during cold stormy weather; slight hoarseness and inability to use the voice long without coughing and clearing out the mucus; more or less catarrh of the nose; some degree of deafness, and, perhaps, tinnitus.

The mucous membrane of the throat and pharynx is of a crimson color, rough, swollen and succulent; but the vessels are not to be seen in the general congestion. The follicular glands par-

ticipate in the general inflammation and hyperplasia of the mucous membrane and submucous connective tissue, but are little distinguished in the general tumefaction. The soft palate is hyperæmic and thickened; the uvula is œdematous, and either elongated or thick and knobby; the pillars of the fauces stand out in great massive rolls during gagging, and the whole buccal pharynx fills the space between with a membrane, ridged and rough with enlarged papillæ and acinous glands, frequently having clots of jelly-like mucus clinging to the surface, and, perhaps, extending up behind the veil of the palate.

The space between the palate and the posterior pharyngeal wall is so much diminished by the swelling, and the throat is so sensitive to the touch of instruments, that it is very difficult to see the condition of the mouths of the Eustachian tubes, and the naso-pharynx, but this may be surmised from the state of the parts below, and made certain by using the catheter, Zaufal's speculum, and the finger.

This particular form of pharyngitis occurs in children and adults otherwise healthy, and is common in persons who use tobacco and distilled liquors freely. It is generally accompanied by considerable catarrhal inflammation of the Eustachian tube and tympanum, and requires a well-regulated hygiene and persistent treatment for its cure.

Atrophic Pharyngitis is the opposite of the hypertrophic. The mucous membrane of the whole pharynx and generally of the posterior portion of the nasal fossæ is involved in the morbid process, but the soft palate and tonsils are only slightly affected.

There is dryness, roughness, itching and burning of the throat; occasional attacks of huskiness of voice, when speaking or singing, followed by swallowing or hawking out mucus; dropping of mucus into the throat from the naso-pharynx, when the head is inclined backward; slight soreness in the throat during damp or cold weather; titillations in the throat causing dry shallow cough; rattling in the ears when blowing the nose; fine ringing tinnitus, and some degree of deafness.

The mucous membrane of the throat shows patches of pale pink, yellowish-gray, and deep red. It appears thin, translucent, and shining; clings closely to the flaccid and slender muscles beneath and upon the walls of the pharynx; is sprinkled with

a few rounded elevations, caused by enlarged mucous glands and papillæ, among which dilated and tortuous venous radicles and arterial twigs may be seen meandering. Here and there, groups of larger glands and papillæ, and areas of local hyperæmia form a redder, thicker portion, which is in the condition of chronic inflammation, which precedes the atrophic state shown by the surrounding paler membrane.

Some of the follicular and racemose glands have disappeared and left little spots of ulceration or small, smooth, cicatricial depressions; others are enlarged the size of bird-shot, and form pale, gray, rounded prominences; again, a few may show open mouths, stuffed with retained grayish fatty secretion.

The vault of the pharynx is moister than the parts below, owing to the hypersecretion of the adenoid tissue, which shows its ridges pink and juicy.

The groups of large glands about the mouths of the Eustachian tubes and the chain that reaches between them are generally quite prominent and pregnant with glandular secretion. Shreds and strings of tenacious mucus are seen adhering to the walls of the pharynx and working slowly down its posterior surface, while jelly-like clots lie in the depressions about the tubes and in the fossæ of Rosenmüller.

The uvula is often elongated and slender, and rests upon the base of the tongue or adheres to the right or left arch of the velum, as if devoid of muscular power—a thing the sport of circumstances. The veil of the palate is sometimes very deep from relaxation or paresis, and occasionally one side hangs lower than the other from the latter cause, as emphasized by Dr. Woakes.

During a recent visit (1881) to London, I had the pleasure of examining with Dr. Woakes, at the London Throat Hospital, some of the typical cases of paresis of the palate described by him. The soft palates drooped excessively; some of them hung at least two inches below the palate bones, but they seemed to perform their functions well. All of the patients had impaired hearing, but they presented, also, conditions of pharyngitis and chronic inflammation of the middle ear.

I was not convinced that the paresis caused the deafness. I

regarded it as a concomitant rather than a cause of the aural condition. I must say that a clear paretic condition of the palate, such as described and theorized about so exquisitely by our Transatlantic cousin, is exceedingly rare in the United States.

The muscles of the throat and pharynx, though evidently partially atrophied and, therefore, weak, act with great promptness and efficiency in many cases. During examination, the upward movement of the velum is often so great, as to clearly show the position of the posterior border of the palate bones.

The palato-glossus and palato-pharyngeus stand out like thin ribbons during gagging, and the weakness of the latter and the palate muscles is made apparent by attempts to inflate the ears with the air-bag during the act of swallowing. A moderate puff will burst open the partition between the naso-pharynx and throat, the cheeks will bulge outward, and the air escape by the mouth.

This weakness is again proved in some cases by the passage of food, during an otherwise normal deglutition, from the throat up into the vault of the pharynx, and into the nasal fossæ. I have noticed this in several patients. A lady ate pudding, and some unchewed *raisins*, a little while afterwards, were blown out of the nose. Another ate some grapes, and, some hours later, one was removed from the anterior nares. Others have complained to me of bread and apples passing in this malapropos way. In every case, the patient was unconscious of the reversion of nutriment until it appeared in the handkerchief. I think the debility of the muscles will account for most of these phenomena.

The velum is sometimes paralyzed after diphtheria; swallowing is clumsily performed; the local sensibility is impaired; the voice is imperfect and has a nasal tone, and the consonants *b*, *d* and *g* are pronounced *m*, *n* and *ng*. The tensor and levator palati and the pharyngeal constrictor muscles are paretic, and symptoms of ear disorder appear, if the lesion lasts very long.

Atrophic pharyngitis demands earnest attention, because it interferes with the physiological action of the Eustachian tube, and thus menaces the integrity of the middle ear. This kind of pharyngitis is rare in children, advances slowly and insidiously in

strumous and tuberculous youths and adults, and is frequently seen in old people.

Granular Pharyngitis is intermediate in symptoms and pathology with the hypertrophic and atrophic varieties, and is very common and very obstinate to treat. There is no atrophy, and very little hypertrophy. The symptoms are not very marked, and include many of those enumerated already. There is dryness and a sense of discomfort in the throat, and tough pieces of mucus are hawked out frequently. The patient is likely to have a stopped nose during sleep, and to breathe through the mouth, so that the throat becomes parched and awakens him. Acute exacerbations of inflammation, sometimes accompanied by tonsillitis and laryngitis, are rather frequent, and each attack aggravates the existing congestion, and leaves it worse than before. The throat, pharynx, and posterior nares are of a uniform deep pink or florid hue; there is an active hyperæmia of the mucous membrane; its epithelium is thick and velvety; the mucous glands and papillæ of the sides and back of the pharynx are distinct, and greatly enlarged; sessile and pedunculated tumors, formed by hypertrophied glands and fungoid granulations, are seen here and there, causing irritation and increased secretion of slimy mucus; the glands of the anterior surface of the velum show as small points, and sometimes injected arterial twigs are seen extending even to the roof of the mouth.

The tonsils are of natural size or enlarged; the velum and pillars of the fauces are of normal thickness; there is no apparent thickening of the muscles and submucous connective tissue, and the parts act well during respiration and deglutition. The mucous membrane is principally affected, and its granular surface and hypersecretion constitute the salient symptoms. The disease may pass into the hypertrophic or the atrophic variety, but usually it remains with little change for a long time, the common property of the inhabitants of cold and inhospitable climates.

This condition of the throat is seen in a large proportion of the cases of chronic inflammation of the Eustachian tube and tympanum, and the patients are mostly adults.

Post-pharyngeal Abscess.—This consists of a collection of pus beneath the mucous membrane at the back of the pharynx,

in the middle or upon one side. The most frequent cause of this accumulation is inflammation of the submucous connective tissue, arising idiopathically in strumous or debilitated constitutions, or originating in disease of the throat. A small percentage of cases are sequelæ of burrowing cervical abscesses, and disease of the cervical vertebræ.

A small, round or oval tumor develops in the pharynx, accompanied by symptoms of the morbid condition upon which it depends. It is oftener seen upon the side just behind the tonsil, than in the middle of the pharynx. It projects forward, interferes with respiration and deglutition, occasionally causes suffocative symptoms, can be seen and felt in the pharynx, and sometimes detected by palpation at the angle of the jaw.

The prognosis is good, when the affection does not arise from disease of the vertebræ, but the pus must be evacuated early, as it may burrow down the neck or burst unexpectedly into the trachea. Of 144 cases from various causes in children, treated by Dr. Bokai, of Pesth, Austria, the mortality was eleven.*

The medical treatment of this affection must be determined by the morbid conditions that attend it. The abscess must be evacuated by the aspirator or a long bistoury, as soon as fluctuation is detected.

Chronic Inflammation of the Eustachian Tube, of moderate degree, often exists in patients with very little implication of the tympanum. After it has continued a while untreated, or has passed a certain stage, the middle ear becomes involved in the morbid process, and the aural symptoms increase in prominence.

The mucous membrane of the mouth of the tube becomes congested and swollen, in sympathy or connection with some of the diseases in associate parts. The inflammation extends along the mucous lining towards the tympanum, but is limited for some time to the cartilaginous portion of the tube, as the symptoms abundantly testify. These symptoms remain after acute ones have disappeared, or come on so insidiously as to attract little attention.

There is usually a slight sympathetic uneasiness in the external auditory canal. The membrane is of normal color or a little

* Archives of Otology; New York City, N. Y.; 1881.

redder than usual along the malleus handle. The patient finds it necessary to clear mucus from his throat often, and has some of the symptoms given under nasal and pharyngeal diseases. He hears a soft click and mucous rattling, with a rush of air into the middle ear, when he blows his nose. The click is caused by separation of the adhering mucous surfaces, as the air forces them apart, and the rattling by the sero-mucus in the tube.

There has been a little ringing in the ear which has now ceased; the ears feel full a little while, because the walls of the tube being swollen and stuck together by mucus, the excess of intratympanic air cannot immediately escape and restore equilibrium. The hearing is dulled at first from this over-distension of the tympanum, but improves, as the excess of air is absorbed, or as it escapes by pressing the tube open, when assisted by swallowing, by a jar of the body, or by movements of the lower jaw. Valsalvian inflation produces similar symptoms, but sometimes where there is much swelling or mucus, this does not succeed, and it is hard to inflate, even, with the air-bag and catheter. The mouth of the tube is obstructed and inflation difficult, also, when there is relaxation or paresis of the palato-tubal muscles. If the patient swallows during the act of inflation, it will aid considerably in opening the tube. Introduction of the catheter will sometimes cause much pain and some hemorrhage from the mucous membrane. This comes from spasm of the muscles, causing the palate to contract upon the end of the catheter, and may be prevented by having the patient breathe all the time through the nose.

The auscultation tube in position, when inflation succeeds, will bring to the examiner's ear the sound of distant râles. These may be sounds of simple moist bubbling or loud, coarse rattling, owing to the tube being quite full of secretion. This latter condition is common in children with enlarged tonsils and granular pharyngitis.

The hearing should be tested by the watch both before and after inflation, in order to determine its effect. The watch and fork are heard in mild cases almost as well as in the normal state.

Five or six inflations should be made the first visit, to expel

mucus from the tube, before the therapeutic value of the action can be known. There is no danger of forcing mucus into the tympanum, as it clings to the walls of the tube, and permits the air to pass by or through it. Too frequent inflation is injurious, but it should be done as often as needed, else mischief will ensue. If inflation succeeds and the hearing does not improve, one can be certain of disease in other parts of the auditory apparatus.

There is no pain in simple tubal catarrh but in acute exacerbations or ulcerated conditions, it may be of moderate degree. Damp and cold weather increases the symptoms, and dry warm weather ameliorates them. Anything that irritates the throat, as spices, spirituous liquors and tobacco, aggravates the disease. The patient is hardly conscious of any change in his hearing from these, unless the morbid state is severe.

The laryngeal mirror will reveal the condition of the nasopharynx and mouths of the tubes. In some patients, the short distance between the palate and posterior pharyngeal wall or the great sensibility of the throat will prevent an examination with the mirror. The index finger may be passed up behind the palate and give a good idea of the conditions. A glimpse may be sometimes gained through the nasal fossa by a Zaufal's speculum, but this is necessarily imperfect knowledge of doubtful value. A tolerably accurate conception of the disease can be had from the totality of symptoms attainable.

Post-mortem examinations at different stages of tubal disease have cleared up the pathology of the region.

The mucous membrane of the tube may be pink, relaxed, and covered with a moist slime, in mild cases; in others, it is in a condition of cellular infiltration and congestion. This is of different degrees, from a delicate capillary injection, to an enlarged network of arteries and veins, which extend out of the tube and upon the pharyngeal wall. In the meshes, there may be minute hemorrhages, or large extravasations from ruptured vessels, and, if these are old, they will appear as gray and grayish-black pigment spots. The lumen of the tube occasionally contains blood clots.

Hyperæmia, originating in the pharynx and mouth of the tube, diminishes as it approaches the tympanum. When the hyperæ-

mia originates in the tympanum, it may diminish in the tube towards the pharynx.

The tube contains more or less mucus mixed with free ciliated epithelial cells. This may be quite fluid, owing to a large proportion of serum present, or like jelly from diminution of it. In the latter form, it consolidates into pellets and strings, occludes the canal, and plugs the pharyngeal opening.

In the graver varieties of Eustachian inflammation, there is hyperplasia of the submucous connective tissue; the muciparous glands become hypertrophied, and the surface of the mucosa, rough, granular, and elevated into longitudinal wrinkles. Swelling is rare in the osseous portion of the tube, increases towards the pharynx, often closes the tube at the isthmus, and converts the opening to a mere slit. Of course, the difficulty of inflation and other treatment increases with the disease.

Ulceration takes place in all parts of the tube, affecting by preference the pharyngeal extremity, and the cicatrices that result frequently constrict and even shut up the canal.

Fibrous adhesions and bands have been found in the tube, as a result of chronic inflammation; especially, at the tympanic end, when disease of the tympanum or temporal bone has coexisted. Polypus and other tumors very seldom appear, and foreign bodies are rarely found in the tube. Such cases are curiosities of aural literature.

There are other sources of constriction or stenosis of the tube. Schwartze mentions œdema of the mouth of the tube during congestion of the superior vena cava; insufficiency of the palato-tubal muscles in fissure of the palate; and hyperostosis near the tympanic orifice. He says: "Stenosis in the middle portion of the canal appears to be extremely rare. It is in practice, from inexact observation, thought to be much more common than it is in reality. Not infrequently an angular bend in the course of the tube, or a projection of the carotid canal into the osseous tube is mistaken for stenosis on attempting to pass a bougie. Real strictures in the sense in which urethral strictures are formed, by thickening and atrophic shortening of the tissues, appears not to occur in the Eustachian tube."*

* The Pathological Anatomy of the Ear, Schwartze, p. 138.

The atrophic, sclerotic, proliferative inflammation of the Eustachian tube differs widely from the catarrhal. It is a sequela of the latter in some cases; in others, it seems to result from a slow subacute inflammation, or from the atrophic changes of senility. There is atrophy of muscles, glands, and epithelium, and diminution of secretion; hardness and dryness of cellular elements, with hyperplasia of the submucous connective tissue.

The mucous membrane sometimes loses its folds, or rugæ, and epithelium, and presents a smooth, inactive surface.

The pharynx may be comparatively healthy, especially in old people, but in most cases either the granular or atrophic pharyngitis will be present. The tube can generally be easily inflated by any of the methods described, and the patient will deftly exhibit his skill in the Valsalvian method, and declare that his ears ought to be all right, since he can blow them out so easily. The hearing for the watch is diminished, owing to the existence of the same proliferative disease in the tympanum, and the fork upon the vertex is not heard quite as well as in normal ears.

When the tympanum is inflated through the catheter, one hears through the auscultation tube a rushing sound of air passing through the tube, ending in a high toned thud or rattle, as the membrana tympani flaps outward. The patient hears the rushing and blow upon the tympanic walls, and is conscious of pressure in the ear, but this is only momentary, because the excess of air escapes as it came, through the patent or easily dilated tube. In some cases that have been preceded by severe catarrh, and in others where there is a gouty diathesis, the tube is sometimes narrowed and even closed by fibrous membrane, and thus inflation is hindered or entirely prevented.

The tube is generally enlarged to three or four times its normal size, on account of atrophy of its soft tissues and osseous walls; the pharyngeal opening is gaping and deep, and its cartilaginous ring shows very plainly, and projects considerably above the surface of the pharynx, so that a decided ridge is felt in manipulating with the catheter.

Very little treatment is required for this condition of the tube different from that adopted for the tympanum, unless obstruction

takes place from local intratubular hyperplasia, which will demand the use of bougies.

Another condition of the Eustachian tubes must be considered, where relaxation or paresis of the soft palate and palato-tubal muscles occurs from exhaustion of the vital powers, mental or physical strain, and general constitutional disease.

Disease of the associate parts is not essential to this condition, but there is usually a pale, flabby state of the mucous membrane and muscles, such as, described under atrophic pharyngitis, but catarrh is not a prominent symptom. There are few signs of ear trouble. There is absence of tinnitus and vertigo, but a slight deafness is generally present, which may have come on suddenly. This varies considerably, being increased when the patient is fatigued, and diminished when rested, and after a night's sleep. The deafness is not progressive, and the membrana tympani is little affected. The velum droops low upon one or both sides; the ear can seldom be inflated by the Valsalvian method, or by the air-bag, except through the catheter, and then the sounds heard with the auscultation tube are a soft click as the tube opens, accompanied by more or less weak râles, and a crackling as the membrane moves outward.

The necessity of the catheter for inflation is considered by Dr. Woakes, as diagnostic of paretic obstruction, but this must be qualified, as several other conditions of the tube require the use of the instrument before air can be forced into the ear. The uvula is short and points or is adherent to the better side, the one not paretic or the least affected, which is generally the right; but it may be œdematous, hang straight down, and rest upon the base of the tongue. The pillars of the fauces are flattened and relaxed, and the parts are partially or entirely insensible to touch.

Dr. Woakes believes, in these cases, the salpingo-pharyngeus and internal pterygoid muscles, supplied respectively by the glossopharyngeal and the third division of the fifth nerves, open the Eustachian tube and keep the tympanum aerated. He thinks, that the tensor palati and tensor tympani muscles, receiving nervous influence from a common source, the otic ganglion, are unable to perform their physiological functions, by which there is relaxation of the muscles around the mouth of the Eustachian

tube, and the drum-head is not held in that delicate state of tension and accommodation seen in the normal state.

Weber-Liel asserts that the paralysis of the palate muscles is accompanied by an antagonistic spasm of the tensor tympani, and this causes depression of the membrana tympani and deafness. This is not reasonable, and I think cannot be demonstrated.

The lack of muscular tonus causes the symptoms given above, and, if the lesion persists long untreated, organic disease of the mucous membrane of the tube and middle ear may supervene. The snares of a drum are drawn according to the pitch desired by the player. The drum-head of the ear is adjusted to sound by the tensor tympani muscle, and its paresis causes considerable deafness. The Eustachian tube must be kept open and the tympanum full of air, until medical and other means shall restore the nerves to their normal activity.

Chronic Inflammation of the Tympanum.—Chronic inflammation of the tube and tympanum arises simultaneously from a common cause, and continues as an entity, the morbid condition of each part reacting upon the other. Chronic inflammation of the Eustachian tube of long duration or considerable severity finally involves the tympanum. Chronic inflammation of the tympanum originates in some affection of the external canal and drum-head, or from a general cause operating through these, as the rheumatic or gouty diathesis or the degenerations of senility. It may continue limited to the middle ear, as found in a few cases of proliferation and sclerosis, but the affection generally extends along the Eustachian tube to its pharyngeal extremity.

Chronic inflammation of the tympanum of the catarrhal variety is invariably connected with the same disease in the tube. There is subacute inflammation of the mucous membrane, with increased secretion of sero-mucus, and considerable impairment of hearing. The patient has become suddenly conscious of his infirmity in one or both ears, on account of an increase of symptoms or having his attention called to the ears in some way, or he has known that his throat and ears have been in an uncomfortable condition

for some time. He may trace the affection to some special cold he has taken or to repeated colds at intervals, but frequently the disease has advanced so stealthily, especially, when the pharynx is in a morbid state, that the beginning cannot be approximately stated. The patient is conscious he has ears, owing to a sense of fulness or a stopped feeling in them. He can locate this deep within. It is not a sensation of external canal obstruction, but of pressure somewhere between the canal and throat. The sensation varies from a slightly thick feeling to one of considerable tension. Cold air, damp weather, a glass of beer or wine, smoking a cigar, and the horizontal position will increase the fulness and attract attention. At the same time, a tinnitus which is present in most cases increases. It is frequently a fine ringing, and this has a rhythm of increase and decrease synchronous with the carotid pulsation. Occasionally the voice resounds in the ear in a distressing manner every time the patient speaks. The tinnitus may be hissing, whiffing, rushing, roaring, rumbling, etc., according to the grade of the disease. It is raised a note or two sometimes, when the lower jaw is moved in chewing. It may cease entirely at times, and then come on suddenly and decidedly. It may be so feeble in tone, that silence is necessary for the patient to tell whether or not it is present, or it may be so loud the patient cannot sleep or perform mental labor well. When it increases with fatigue, and the fork indicates diminished cranial perception, the labyrinth is generally diseased. Perforation of the membrana tympani may cause it to cease for a time or increase its volume. If the tympanum becomes filled with mucus, it often ceases altogether or become coarse and rhythmic. It increases with the disease, and often ceases in late stages. Inflation of the tube and ear with the air-bag often causes it to disappear for hours or days. Inflation is the most essential measure for its permanent removal.

There is occasionally a soft clicking heard, such as one can make with the tongue against the roof of the mouth, occasioned by the opening of the Eustachian tube, owing to spasmodic action of the palato-tubal muscles. Cracking is heard in spasmodic contractions of the tensor tympani, acting upon the membrane. In drier cases, crackling is produced by movements of the same,

when the air goes in, and again when it escapes. There are mucous râles in the tube and drum during swallowing, but the air does not make a distinct crackling in the ear, as when the parts are healthy. The patient is morbidly sensitive about his deafness, and will frequently deny it stoutly; he thinks persons around him speak very low.

The hearing is considerably diminished, the watch can be heard only a few inches, the fork vibrating upon the vertex is not heard well, voices sound muffled, there is inability to catch certain letters and syllables, and the patient is obliged to ask for the repetition of words and sentences.

The vowel sounds are as often mistaken as the consonants. In a case with Hw. $\frac{4}{6}$, it was difficult to distinguish between *a* and *k*, *e* and *d*, *g* and *t*, *g* and *z*, *i* and *r*, *j* and *k*, *m* and *n*, *p* and *t*, *t* and *z*, and *q* and *u*.

Audition varies with the phases of the disease, the permeability of the Eustachian tube, and the degree of aeration of the middle ear. Generally the watch can be heard a few inches; in some cases, not on contact. Inflation often lengthens the hearing distance; but it may shorten it exceptionally by forcing mucus from the tube into the ear, by distending the membrane too much, and by moving thicker mucus into improper relations with the chain of ossicles and the inner membrane. Inflation may not change it at all, because a swollen tube may prevent the entrance of air into the ear, or the tube and tympanum stuffed with mucus cannot receive enough air to act upon the parts.

In drier cases of chronic inflammation, hearing is often better in a noise. The stiffened articulations of the ossicles, and the thickened membrane of the round and oval windows are supposed to be limbered up and loosened by the strong vibrations of loud sounds, so that feebler ones acting harmoniously with them are perceived by the auditory filaments. The latter effects may be compared to the air of a melody, tinkling in dulcet tones through and above the louder and more powerful tones of variations.

Notwithstanding the diminution of auditory power, the patient much of the time has a sensation as if his hearing were exceedingly acute. There is a hyperæsthesia of the auditory nerve, a

morbid sensibility to all sounds; the ears are on the *qui vive* for any and every sound around, and those unexpected or louder than usual, cause discomfort in the ear closely allied to pain. Indeed, pain is occasionally caused in this disease by loud sounds.

The external ear is hypersensitive to touch and drafts of air. The patient manifests much timidity during examination, and shrinks at the touch of fingers and speculum. There is discomfort in the external ear from exposure to dampness, cold air or wind. This increases to a slight aching in the ear, with occasional darts of pain along the Eustachian tube to the throat, which is often a little sore upon one or both sides. This soreness is common in the morning after exposure to night-air, but disappears soon after breakfast. Patients say they cannot sit out of doors after dark in summer or take a ride in the wind without the ears aching, unless they wrap up the head or stop the ears with cotton or wool.

Vertigo is another symptom in this disease, though it is sometimes absent. It is generally mild and inconstant, but may be severe enough to make the patient stagger, and grasp hold of something to prevent falling.

Severe attacks of vertigo are occasionally caused by disorder of the stomach, and are accompanied by flatulence, nausea, increased tinnitus, and deafness.

Peripheral irritation of the pneumogastric nerve in the stomach passes by a branch from the trunk to the inferior cervical sympathetic ganglion; this gives vaso-motor nerves to the cerebral arteries, which anastomose with the vessels of the labyrinth, and these with those of the tympanum. The ganglion, also, gives off the inferior cardiac branches. Through this ganglion the circulation of blood in the ear, already disturbed by the aural disease, is further disordered; the labyrinthine pressure is altered, and vertigo results.

Giddiness comes on frequently from variations in the intra-tympanic pressure. When the Eustachian tube is obstructed, and the air of the tympanum is rarefied, the external air presses the membrana tympani inward, and the ossicles transmit this pressure to the membrane of the foramen ovale and the labyrinthine

fluid. This condition predisposes to tinnitus upon slight plus or minus variations of pressure, occasioned by temporary anæmia or hyperæmia, and by aerial and mechanical changes in the tympanum. The simple pressure comes on so gradually, that the auditory filaments become accustomed to it, and require a perturbation of some sort to excite the vertigo. The cochlear nerves respond to the fluid agitation by tinnitus, and the vestibular by rotating affections of the body's equilibrium.

Sudden movements of mucus in the tympanum, brought about by action of the membrana tympani, the tensor tympani muscle, or the Eustachian tube, often furnish an exciting cause of vertigo. Moderate inflations do not usually cause vertigo, because the air goes into the tympanum, strikes and pushes the drum-head out and the foramen rotundum in, and thus in a measure, forces the stapes outwards, and counteracts the direct pressure of the air upon the foot-plate and its consequent action upon the vestibular currents.

When the drum-head is thick and rigid and the ossicles ankylosed, inflation will often cause distressing vertigo. Powerful inflations of air, by over-distending the tympanum, tearing adhesions, and pressing violently upon the stapes and round window, may cause vertigo, syncope, and unconsciousness.

A lady patient had depressed and adherent drum-head, stiffening of the articulations of the ossicles, and considerable tympanic mucous secretion. I inflated very strongly through a catheter, she turned pale, fainted, and I caught her as she fell off the chair, and placed her upon a lounge. The pulse was very feeble and face ghastly. I put Spirits of Ammonia to her nostrils, and bathed the face in Spirits of Camphor until she became conscious; then, as the depression continued, I gave her a few drops of Compound Spirits of Ether. It was half an hour before she was able to go home, and several hours before she felt all right again. She said, that when I compressed the air-bag, she felt a sudden loud report in the affected ear, and then darkness and silence reigned. When I examined the membrane, I thought it moved outward rather more than before, under the influence of Seigle's speculum, and concluded an adhesive band or an ankylosis had given way from the violent inflation. I do not inflate very strongly now,

unless with the design of freeing the membrane or making the chain of bones more supple.

Drs. Roosa and Ely have reported a very alarming case of syncope from syringing and cleaning the ear, in the case of a gentleman with purulent disease of the tympanum.

I shall treat of the vertigo of Ménière's disease elsewhere. The symptoms of disease in the Eustachian tube, pharynx, and associate parts have been already presented in previous pages, and should be referred to by the reader.

The voice is frequently affected in chronic inflammation of the tympanum and tube. It loses its clearness and volume, and cannot express the higher notes of the musical scale without great effort, and then only for a short time. The voice cracks, breaks, and becomes hoarse or squeaking, when an attempt is made to sing high notes, or when the effort is prolonged. A slight exacerbation of moderate and unsuspected tubal and tympanic inflammation with little throat affection in a singer, broke his voice so that he could not sing within several notes of his accustomed place. Trying in my presence, he sang up the scale as usual, but could not maintain nor give volume to the upper notes, and soon began to cough. He said the effort made his larynx ache, and the anterior muscles of the neck very tired. The laryngeal mucous membrane was a little hyperæmic, and the posterior pharynx roughened. A few weeks treatment of the throat and ears restored his voice to its former range.

Another patient, with chronic aural disease of some severity and long continuance, was distressed because he could no longer speak or sing at prayer-meeting. He had Hw. $\frac{6}{8}$, a dry condition of the tubes and tympana, and a slightly granular pharynx. When he talked or sang a few moments, his voice would become harsh, his throat itch, and a dry, hacking cough would force him to cease. The mucous membrane of the larynx was normal, and the muscles acted harmoniously. Treatment for a year improved the hearing a little, smoothed the pharynx, and perfectly restored the vocal powers.

As deafness increases, the patient loses that nice distinction of tones by which he regulates the smoothness and volume of vocalization; the voice gradually becomes unrhythmical and unmusical,

and takes a sharpened or querulous tone, anything but pleasant for the listeners. It has been my fortune never to have had but one patient, who was totally deaf and not dumb. He was a powerful and hearty blacksmith, 56 years old; he could not distinguish shouted words, and carried a slate and pencil. The membranæ tympanorum were entirely adherent to the inner walls of the ears; inflation produced no effect, and the tuning-fork on the vertex and mastoid was heard only faintly. The disease had existed for fifteen years, and was caused by dipping the head in water when sweating. The trumpet, and concert dentaphone were, of course, useless, and writing and signs were my only means of communication with him, but he could speak readily enough. His articulation was loud, harsh, of variable volume, and in irregular jerky tones.

Affections of the voice in chronic inflammation of the tympanum depend, in a large majority of cases upon congestion or inflammation of the mucous membrane of the larynx, originating independently, or caused by the pharyngeal and throat diseases so commonly present. Weber-Liel and Woakes believe that the laryngeal trouble may arise through reflex action from the ear. The auricular branch of the pneumogastric nerve transmits an impression from the external auditory canal to the trunk of the vagus, and its superior laryngeal branch excites the respiratory centre in the medulla oblongata, and causes contraction of the crico-thyroid muscle.

The auricular irritation passes, also, through the inferior ganglion of the vagus and a communicating nerve filament to the superior cervical sympathetic ganglion, which supplies vaso-motor nerves to the carotid branches that nourish the tissues of the larynx. The tympanic branch of the glosso-pharyngeal and its main trunk anastomose with the vagus and its auricular branch, and with the superior cervical sympathetic ganglion, and bring the tympanum into nervous communication with the muscles and mucous membrane of the pharynx and larynx. The ear is thus brought into intimate relationship with the organ of voice.

Disorders of function and nutrition in one part may bring on sympathetic affection in the other. The larynx may become

affected by ear disease, and the ear may become affected from laryngeal disease. A foreign body in the ear may cause coughing and sneezing; blowing in the meatus induce nausea and vomiting; a cold blast in the ear excite catarrh and croup; a bougie pushed into the isthmus of the Eustachian tube produce laryngeal pain; and disease of the middle ear develop laryngeal congestion and inflammation.

Acute inflammation of the larynx causes otalgia and acute inflammation of the tympanum; perichondritis of the crico-arytenoid cartilages is accompanied by otalgia; asthma is followed by deafness; tuberculous disease of the larynx is complicated by purulent inflammation of the middle ear; and a bruised larynx produces deafness and sometimes unconsciousness.

Burnett quotes a case from the records of the Academy of Sciences, of Paris, 1705. "A young man, twenty years old, lost both hearing and speech, after his larynx had been squeezed by a strong man in a fight. All means tried for the restoration of hearing failed in this case."

I saw a similar case in 1879, through the kindness of Dr. J. H. McClelland. A middle-aged laborer in a rolling-mill had been grasped fiercely by the throat and thrust to one side by a fellow-workman. The patient was recumbent, pale and feeble; his pupils were dilated, and his hearing deficient. He could not speak, nor swallow, except a few drops of water at a time, and each attempt brought on distressing choking, owing to paresis of some of the throat muscles and spasm of others. The diagnosis was shock and bruising of the cervical sympathetic ganglia. Ignatia was given, and the man recovered perfectly in two or three days.

Sneezing is a very common symptom in catarrhal otitis, and depends, as much upon increased sensibility to cold, as upon local irritation. It may occur in single explosions, but is oftener in paroxysms during the night or early part of the day. The most trifling exposure or irritation will often cause from one to a dozen sneezes, sometimes violent enough to shake the windows. The outburst is followed by a flow of serum from the nose, and sensations of stuffing and rattling in the ears. Every one has heard the joke about a person taking cold from a draft through a key-

hole, and from leaving the pew door open in church. I am almost ready to believe, that hyperæsthetic victims of catarrhal otitis have furnished evidence upon which such stories are predicated. I have known patients so sensitive they would sneeze repeatedly from exposure to a breath of cold air upon the head, touching a cold object, leaving off a cuff, or collar, changing to lighter shoes or a dressing gown though remaining in a warm room, and from taking cold water or ice cream.

The respiratory centre in the medulla oblongata receives excitations from the nerves of general sensibility upon the surface of the body, especially the trifacial, from the pneumogastric nerve, and the sympathetic system. Aural conditions influence the medulla through the auricular branch of the pneumogastric, the auriculo-temporal branch of the trifacial, and the tympanic branch of the glosso-pharyngeal nerves. The respiratory centre sends a motor impulse along the respiratory motor nerves, the facial, pneumogastric, spinal accessory, intercostals, etc.; a deep inspiration is followed by drawing together of the pillars of the fauces over the base of the tongue, and a violent expulsion of air through the nose. The shock often forces the velum upward, and makes the mucous membrane feel rough and uncomfortable, even, as far forward as the middle of the roof of the mouth. Sneezing warns the patient of danger to the ears by increase of the catarrhal process, and indicates a debilitated state of the health.

Other results of reflex action in aural disease, especially, in the chronic kind I am discussing, are seen in increased vascularity, altered sensibility, and muscular spasm of the parts.

The auricle, side of the head, one cheek, the neck, and, even, the chest and back may become of a carmine hue; the capillaries are distended with blood, and the temperature is raised, as in blushing or the early stage of erythema. The color of the auricle in some places deepens to crimson and, even, purple without running into inflammation, and tinnitus supervenes, or if this has existed previously, it is considerably increased. The attacks are usually sudden and transitory; all the morbid symptoms depart as quickly as they have appeared; only to return again, when local irritation or any emotional excitement furnishes the impetus.

Experimental and pathological lesions of the cervical sympathetic ganglia produce corresponding symptoms to the above, and render it certain, that they are produced through and by the vaso-motor nerves of the sympathetic system. The auricular branch of the pneumogastric and the trifacial, and the tympanic branch of the glosso-pharyngeal join the superior cervical sympathetic ganglion, and bring the external auditory canal and middle ear into direct connection with one of the chain of regulators of the vascular supply of the head and neck, and sufficiently explain the above phenomena.

Sore, spots are felt upon the head, neck, shoulder, and chest, here and there, and neuralgic shocks and pains shoot along the course of nerves upon the same side as the diseased ear. It is not uncommon to find soreness in the region of the inferior semicircular ridge of the occipital bone, over the parietal protuberance, in the temple, and along the side of the neck in front and behind the sterno-cleido-mastoid muscle. Neuralgia is suffered most frequently in acute disease of the ear, but may be present in the chronic stage. Pain darts from the ear to the throat, to the occiput, to the vertex, into one eye, into the teeth, and down the neck. It sometimes take a reverse course.

One of my patients had a severe pain in the teeth of the right lower jaw, in the ear, side of the neck, and middle of the clavicle. The pain over the clavicle was as severe as in the ear or teeth, and I traced out the connection from a newly filled ulcerating tooth, along the inferior dental to the auriculo-temporal branch of the trifacial; by anastomosis of this, to the facial, and along the latter to the auricular branch of the auricularis magnus of the third cervical, which transmitted the irritation by commisure to the fourth cervical nerve, giving off the supra-clavicular to supply the clavicular region where the pain ended.

The reader may trace the course of reflex action in any case of neuralgia with interesting and satisfying certainty, if he feels so inclined.

Muscular spasm is another symptom of not infrequent occurrence, when the ear is in a morbid state. The contraction is limited to a few fibres, or involves the whole bundle forming the

muscle. It occurs in the muscles of the face, neck, and throat, and is occasionally accompanied by objective snapping noises.

I have had one case somewhat similar to Leudet's, reported by Burnett. The patient was a strumous youth, 13 years old, of fair development and growth, but easily exhausted, subject to sudden gastric disturbances and severe headaches, and having suspicious stumpy incisor teeth. He was a little deaf, and had a moderate naso-pharyngeal catarrh, which I did not consider at first, as he was brought to me for eye treatment. I found both the corneæ gray with interstitial keratitis, and vision reduced to counting fingers at one foot. The parents were robust, healthy people with no specific history or symptoms. I was rather suspicious of the father's veracity, because he displayed so much anxiety in regard to the boy's condition, and asked so many questions about the disease, its probable cause and progress. The eye affection yielded rapidly to treatment, and some six weeks after the first visit, I examined the ears, removed masses of altered cerumen and epidermic shreds, and diagnosed chronic, rather dry, catarrhal inflammation of the tympana. I applied glycerine and water to the external canals, inflated the ears with the air-bag, and ordered a salt-water gargle, continuing the eye treatment of mercury as before. After twelve days treatment, he returned unexpectedly, and his father said he was afraid something serious was the matter with the boy, as he had jerking under the jaw of the right side. There were clonic muscular spasms, at the rate of five or six a minute, below the right jaw, and in front of the sterno-cleido-mastoid muscle, in the superior cervical triangle.

They had appeared two days before, and had been continuous during waking hours. There was no pain connected with them, no abnormal sensations in the right ear, nor any cerebral symptoms whatever.

There had been headache, vertigo, and nausea one afternoon, due to a fresh pork dinner and violent exercise immediately after in playing base-ball; but I thought this could not be causative of the phenomenon. The membrana tympani presented the dull gray, opaque color of chronic inflammation of the tympanum noticed at the first examination, but there was added to the pre-

vious condition a marked injection of bloodvessels along the handle of the malleus.

During the spasm, the depression between the larynx and angle of the jaw was elevated, pushed outward laterally, about one-fourth of an inch ; the inferior maxilla was at the same time drawn downward about the same distance, and I could feel the tone of firm contraction under my fingers, pressed upon the inferior maxillary region. The movement was immediately followed by relaxation, the jaw returned to its proper position against the upper one, and the time occupied from beginning to end was not over two seconds, while the interval between the spasms averaged five seconds.

Closing the jaw firmly, depressing it to its full extent, moving it to one side and the other, and pressing firmly upon the muscles had no effect in diminishing the frequency or force of the spasm. Inflation was easily accomplished, and lessened the number of the contractions immediately.

A careful study of the symptoms of this interesting case rendered it certain, that the spasms were confined to the digastric and stylo-hyoid muscles of the right side, and I was gratified to find an anatomical reason for this in the distribution of nerves.

These muscles are under the influence of a filament given off by the facial nerve after its emergence from the stylo-mastoid-foramen, and, in my opinion, this nerve was irritated by the mild exacerbation of inflammation in the tympanum. This would seem reasonable, because a general treatment of the aural catarrh cured the spasm.

Let us see how this might occur. There are several anastomoses between the nerves of the tympanum and the facial, but I shall allude only to those that seem to have transmitted the morbid impulse in this case. The tympanic nerve, a branch of the glosso-pharyngeal, is the great sensitive nerve of the middle ear. It gives off from its plexus in the tympanum a filament, that unites with one from the facial nerve to make the small superficial petrosal, which goes to the otic ganglion. The glosso-pharyngeal filament transmits irritation from the diseased tympanum to the ganglion. This reflects the waves of irritation back along the facial filaments of the small petrosal to the trunk of

the facial, just where its intumescenscia ganglion reinforces its power and aids in controlling its functions, and from here the impulse passes down the nerve to the filament that supplies motor impulse to the stylo-hyoid and digastric muscles. It is probable that other muscles supplied by the facial were influenced in a less degree, and I did not notice their action, because I was not fully posted upon the neurological relations of the phenomenon.

Spasms of the tensor tympani and palato-tubal muscles are quite frequently mentioned in otological writings. It is certain that spasm of the tensor tympani occurs *per se*, and may be involuntary or, rarely, produced at will. It is seldom attended by vertigo. This muscle has a tonus which keeps the membrana tympani at a certain tension for the reception of sound vibrations, but the degree is altered voluntarily, when the mind is concentrated upon auditory sensations in expectant attention.

An irritation in the external meatus or canal, in the tympanum, the Eustachian tube, pharynx or larynx can reach the otic ganglion of the same side through some of the nervous chains already traced, and this may cause spasm of the tensor tympani alone or accompanied by contraction of the tensor palati and other muscles. The drum-head in these cases moves in and out with the abnormal contraction and relaxation of the tensor tympani, as can be seen under illumination, and demonstrated by Politzer's manometer.

The velum moves backward and upward, then returns to its proper pendant position, as the tensor palati and other palate muscles contract and relax.

These muscular actions are occasionally accompanied by an objective clicking sound, which may be heard near the patient, but sometimes, even, at a distance of several feet. It varies in character, and resembles the rattle of parchment, the cracking of the finger-nails, a low clucking like that produced by drawing the tongue away from the roof of the mouth, or the thud produced by snapping the thumb and second finger. The sound is not constant in rhythm; it may be synchronous with the pulse, rapid and intermittent, or increased to as many as 140 clicks a minute.

In a case recorded by Burnett, swallowing, breathing, and speaking arrested the noise; rapid respiration increased it from

twenty to thirty snappings a minute. The tuning-fork rose in pitch with every spasm.

The voluntary production of the sound has generally been in ears that were in a normal state, but the involuntary in those that were affected by various degrees of subacute inflammation. Burnett mentions instances of bilateral and of unilateral contraction of the tensor tympani in normal ears, which were under voluntary control. The involuntary cases of the phenomenon are upon one or both sides, according as one or both ears are diseased; but it is not impossible that the power of the will should be exercised upon the tensor tympani and palato-tubal muscles to produce the sound, even, when disease is present in the tube and ear. The sound originates from muscular contraction, but is not in the muscle itself, but in the parts moved by the muscle. When the tensor tympani contracts spasmodically, there is a rapid movement of the drum-head inward and outward, and this produces a crackle or rattle like that which terminates the sound of inflation in old people, with large, dry Eustachian tubes and tympana. When the palato-tubal muscles are the seat of spasmodic action, the walls of the Eustachian tube are more or less separated by each muscular spasm, and the well-known snapping or clucking sound is heard, followed by a thud and crackling, if air passes into the tympanum.

I have had only one case bearing upon this subject. A gentleman, sixty years of age, had proliferative inflammation of the tympanum, and a loud snapping during swallowing, perceptible a foot away from him. The noise could be heard through the mouth and ear, and coincident with it, the handle of the malleus and the membrane moved inward. I considered this due to spasm of the tensor tympani and exaggerated action of the palato-tubal muscles, induced by the act of swallowing. The sound ceased after a few weeks treatment of the chronic inflammation in the ear.

Burnett was able to stop the sounds in one of his patients by pressing upon the velum, and through this upon the Eustachian tube, though he felt the muscular spasms go on regularly beneath his finger. After spontaneous perforation of the membrana tympani in this case, the noises and the spasms ceased entirely.

.....

On account of this the author recommends "artificial perforation of the drum-head in any similar case, if relief from the symptoms should be urgently required." The induced current, applied to the velum and Eustachian tube, has cured some cases, and may be tried in connection with the treatment for any disease that may exist in the region.

Mental disease is not infrequent in chronic inflammation of the tympanum. It is reasonable that the brain should suffer from reflex action, as do other parts about the ear, since it consists of nervous matter—great ganglia—conscious of all bodily conditions and omnipotent over all. Patients complain of a drawing, strained feeling in the head, as if the scalp were tired and the surface of the brain compressed. The wits are wool-gathering, and thought wanders purposeless from subject to subject without continuity or masterly grasp. The memory is defective, concentration of the mind upon a subject is exceedingly difficult, mental labor must be forced, and causes general fatigue.

When tinnitus is present, nervousness is marked; the patient starts at every unusual or loud noise; is timid in darkness; afraid in crowds and crowded thoroughfares, and apathetic and seemingly stunned in places that require self-possession and quick action.

Vertigo comes now and then to disturb the equilibrium and destroy courage, and, if gastric disorder exists, and adds its cardiac and cerebral disturbances to the picture, the patient may have severe occipital pains and numbness of limbs, and may whirl around and fall down, conscious, but utterly demoralized.

Of course, the above are strongly drawn symptoms of extreme cases. A patient may have one or more of them, mild and endurable, in connection with the aural disease, while another may have most or all of them, and be thoroughly miserable.

When it is remembered that persons have become insane from the presence of impacted cerumen in the external canal, and others have blown their brains out under the torture of a constant tinnitus, the above description will not seem exaggerated.

The objective symptoms and pathology of the catarrhal variety of chronic aural inflammation are so different from those of the

proliferative, that they must be separated in order to avoid confusion.

A state of excessive congestion and secretion is characteristic of some catarrhal cases, and the symptoms connected with this differ much from those given in textbooks upon ear diseases. It is an early stage of chronic aural inflammation, which is not often brought to the aurist's attention. It is, also, a chronic condition in some patients, which seems to have escaped the attention of such celebrated writers as Toynbee, Roosa and Burnett.

The external auditory canal in the early stage is congested and itchy, and contains an excess of cerumen, mixed with dirty white shreds of exfoliated epithelium, loose hairs and dirt. This collection may be sufficient in amount to close the canal, or only enough to fill its depressions and obstruct the speculum, as it is pushed into position for ocular examination. The membrana tympani is in such cases rosy or dull red; its vessels may not be visible, or some will be seen passing from the canal upon the membrane towards its centre, and others running from above down along the posterior border of the malleus handle to the umbo. There may be cicatrices of healed perforations visible. The light triangle is dimmed in lustre, diminished in size, elongated, bisected, or entirely absent.

In rare cases, the membrane will permit one to see the level of a secretion or of blood in the tympanum, and these coexist with syphilis, heart disease, lung affections, and Bright's disease; but, generally, there is so much opacity that nothing can be seen within. The manubrium of the malleus is obscured or shows a yellow knob on the lower end, and the general thickening and sogginess of the drum-head interfere with its elasticity and mobility, so that it moves outward and the malleus handle moves forward very slowly, when Seigle's speculum is operated or inflation is performed.

There is little depression in this disease. Greater pressure is required to push a thicker membrane inwards. There is so much sero-mucus in the tympanum that it acts by counter pressure, and air goes through the mucus in the tube to the tympanum to some extent to augment this, and prevent that marked depression seen in later and drier stages.

The tympanum, mastoid cells, and Eustachian tube are partially or entirely filled with clear or yellowish sero-mucus, sometimes reddened by exuded blood; thicker mucus clings to the angles and depressions; the ossicles and tensor tympani are clogged by it; the foot-plate of the stapes and its oval membrane, and the membrane of the round window are pushed inwards, and augment the pressure of the labyrinthine fluid. Constant pressure of mucus against the membrana tympani is likely to cause thinning, and this predisposes to easy rupture.

Inflation is often not felt in the ears, and the auscultation tube will leave one in doubt whether he has heard râles, though a few bubbling ones can generally be distinguished. Swallowing during the act of inflation will aid in opening the tube. The middle ear is stuffed with secretion, and while the fork on the vertex is heard rather exaggerated, the watch may not furnish any sound to the expectant ear.

The mucous membrane of the tympanum, mastoid cells and Eustachian tube is deep red or purplish, succulent and velvety. The epithelium is spongy, and here and there presents granular patches and villous processes; there is passive congestion; the blood moves slowly; the veins are distended and show elongation and varicose swellings; ecchymoses are not uncommon; the submucous connective tissue is hypertrophied, and its meshes filled with leucocytes; the tubular and racemose glands are hypertrophied and dilated; and the mucosa generally thickened. This is limited to certain parts, to the drum-head, the articulations of the ossicles, and the round window, or is more general over the whole surface of the limiting bone. It diminishes the size of the tympanum, and may be so considerable as to obliterate the entire cavity. If the disease continues any length of time, bands and new membranes are produced, and contractions and adhesions supervene.

This wet form of chronic inflammation of the middle ear remains wet for a long time, is obnoxious to treatment, and very discouraging to both patient and physician; but it so surely tends to sclerotic and proliferative processes, and destruction of the hearing power, that continuous and energetic treatment is imper-

ative. The mild cases and, even, some of the worst ones sometimes get well, and all can be greatly improved.

Schwartz says: "The very highest degrees of catarrhal swelling of the tympanic mucous membrane are capable of complete retrogression, the membrane resuming its cobweb-like delicacy, and moulding itself accurately to the osseous walls and contents of the tympanic cavity. The cellular infiltration of the subepithelial connective tissue disappears by fatty degeneration and decay, and possibly, in part, by being absorbed into the lymph vessels. For this purpose weeks are necessary. In many cases, however, retrogression is incomplete, and there remain projections and duplicatures of the mucous membrane in the form of pseudomembranes or synechiæ, by which different parts of the ear are abnormally adherent, or the tympanic cavity is permanently affected in its size and form."*

Moderate secretion in the tympanum and tube and an absence of congestion characterize the second stage of some acute inflammations of the middle ear without perforation of the drum-head, as well, as subacute inflammations primarily accompanied by excessive secretion, some primary subacute inflammations of the tympanum, and various morbid processes arising therein from tubal disease. The symptoms of this state are very different from those just given. It is the morbid condition fully described in most textbooks upon aural disease, as chronic catarrhal inflammation of the middle ear. It is the one most frequently seen in practice, because persons attacked with aural catarrh do not generally apply for treatment until degenerations have occurred, and deafness and tinnitus have awakened anxiety. It properly includes both mild catarrhal and proliferative cases.

The external auditory canal, in the less humid inflammation, is yellowish-white mixed with gray. It is dry, scaly, itchy; contains little or no cerumen; is sensitive to cold, and in sympathy with the morbid changes within.

The membrana tympani is thickened, and has lost its clean, healthy, bluish-gray lustre. It varies in color from opaque

* The Pathological Anatomy of the Ear, Schwartz, p. 95.

creamy yellow to dull gray, and its periphery often shows a yellowish-white ring of thickening.

The light triangle when present is dimmed, so that it is difficult to determine where the canal ends and the membrane begins; the color is like asbestos, blue granite, or ground glass. Its area is diminished and shape altered. It may be elongated into a slender line; bisected horizontally, so that it shows a crescent at the base and a point of light near the umbo; broadened and shortened to a blunt cone; scattered in three or four light points; or entirely blotted out. One or more dirty white spots of calcareous degeneration may be seen in the membrane, for the most part, in the middle portion, though, rarely, they extend in crescentic form along the periphery. Old cicatrices when present and small show as gray or yellowish-white marks, a little depressed below the surface, and may project outward like little blisters, when inflation is performed. When they are large, they are darker than the rest of the drum-head.

The manubrium of the malleus has a yellowish-gray color, its edges seem to have additions of cartilage, and there is a sort of disk of the same color around the lower end which gives it a knob-like appearance. A few vessels may course along its posterior border and above the short process. The short process projects above the surface, as a yellowish-white button that catches the eye quickly, and from this the anterior and posterior folds of mucous membrane upon the inner surface of the drum-head can be seen, passing to the periphery in sharply drawn lines. The greater the retraction of the malleus handle, and depression of the membrana tympani, the more noticeable these folds and the short process become.

The tympanic changes and the obstructions of the Eustachian tube rarefy the air in the ear, and the air pressing upon the outer surface of the drum-head forces it inward.

The handle of the malleus is drawn inward by the tensor tympani muscle, and pushed in by atmospheric depression of the drum-head, in various degrees. It may hang nearly in proper position, or be drawn or pressed inward and backward, until, in the foreshortened view, its length seems diminished more than one-half.

It is not certain that the tensor tympani is in a state of tension, in every case of depression of the drum-head. I have seen cases of air-depressed membrane, where the plane of the outer surface of the manubrium remained nearly in the same plane with the membrane, and it was evident from this, and the restoration of both to the normal position by inflation and other treatment, that the tensor tympani was not affected. In other cases of depression, the anterior edge of the manubrium was turned sharply inward, and the posterior border made a sharp line over which the drum-head seemed drawn tightly, making a tolerably plane surface of membrane behind, and a deep dark pocket in front. These could not be restored by inflation and treatment, probably because the tensor tympani was in a state of spastic contraction or rigidity.

Weber-Leil thinks the tensor tympani is continuous with the palato-tubal muscles, and, when the latter become diseased and relaxed, the former becomes contracted antagonistically. This is mere theory, and there are a great many facts to render it untenable.

The cause of retraction of the manubrium is of value in prognosis, and has a bearing upon the operation of tenotomy of the tensor tympani. When the drum-head is depressed or retracted, it becomes more concave and of very irregular surface. If it is thin and partially transparent, the long process of the incus, the pinkish-white promontory, clots of mucus and blood, and air-bubbles may occasionally be seen through it.

Adhesions of the membrane to the inner wall of the tympanum are bluish or yellowish-white, and do not move during inflation, by which they can be distinguished from cicatrices. Inflation moves the drum-head considerably outwards when not adherent, and causes increased redness around the upper part of the malleus handle. These changes are to be observed when the patient practices the Valsalvian method of inflation, and the aurist illuminates and watches the membrane.

If the ossicles are fixed and the malleus handle and portions of the membrane adherent direct or through the intervention of bands, portions of the membrane will move out in bulbous or

balloon-like processes, while the other parts will darken and remain immovable. With Siegle's speculum one can draw these loose places out and show their character and extent perfectly.

It would be a tedious and useless labor to describe the various pictures of distorted membranes met with in this disease. They are as numerous and curious as the figures in a kaleidoscope, and should I write down all the varieties I have seen, I would have to add to them day by day as patients presented.

Authors state that, in rare cases, the tympanic membrane loses its normal color and transparency, without there being any disease in the middle ear. Of course, this might happen from the domestic treatment of earache, or from disease confined to the membrane.

No one would make a diagnosis of chronic inflammation of the tympanum from these drum-head symptoms alone.

In other patients with the tympanic disease under consideration, the membrane may be normal in appearance, because other portions of the mucous membrane are affected, and that covering the inner surface of the drum-head has escaped. The membrane may present any of the above conditions in the dry proliferative stage, and the sclerotic and atrophic changes of senility. Then it may be thinned by atrophy, and flap in and out like the mainsail of a schooner lying head to the wind.

In the stage of tympanic inflammation under consideration, the sounds heard through the auscultation tube during inflation vary with the condition of the Eustachian tube. Valsalva's method gives the purest sound, and should be preferred in testing. Sometimes the tube is obstructed by plugs of mucus, swellings, fibrous membranes or bands, and exostoses; then nothing is perceived during inflation but the sound of the velum's movement. In such an event, introduce a catheter and try again. If not successful, rotate the catheter a little, as it may have got into a follicle or against a fold of the mucous membrane from which a little manipulation may free it. The sound through a small catheter is higher than through a large one, and should be recognized apart from the tubal and tympanic noises. The catheter

whistle should be learned by forcing air through it with the air-bag before using it in the ear.

If obstruction persists, pass a bougie smeared with cold cream through the catheter down to it, and push gently onwards, turning it now and then till a sudden freedom is felt as it enters the tympanum. To guard against error and injury, it is well to measure the length of the catheter upon the bougie, add to this the estimated length of the Eustachian tube and mark both places upon the bougie, then push it through the catheter into the tube until the outer mark is reached, and the obstruction is passed. Only a very moderate degree of force is permissible; inflation may be performed the next day after the tube is made pervious, but not the same day, on account of the danger of producing emphysema.

There is a good deal of bugbear about this danger, because a travelling quack once produced it by applying an air (force) pump to the tube. Ordinary inflation will never produce emphysema, unless instruments have torn the mucous membrane of the Eustachian tube beforehand.

When inflation succeeds, rather loud râles are heard, mingled with cracking and snapping, and the usual thud. A moment or two after inflation, the patient sometimes hears a cracking as some air escapes into the throat; the sensation of fulness goes away from the ear, and the membrana tympani falls inwards to a state of equilibrium.

When the tympanum and tube are dry, and the latter is enlarged, as in many cases of proliferative inflammation and senile atrophy, the air by Valsalva's or Politzer's method goes into the ear with a loud rush and cracking sound. The membrane, if free and thin, flaps outward and makes a noise that can occasionally be heard by an observer at several feet distance.

Inflation may sometimes cause tinnitus to cease, but it generally only elevates its tone, and reddens the drum-head along the handle of the malleus, showing an induced hyperæmia.

The mucous membrane of the middle ear passes gradually from the state of congestion and swelling to that of hypertrophy of the connective tissue, and development of fibres, bands, and false membranes. The glands are destroyed by increase and contraction of the connective tissue in which they lie; the vessels

are diminished in size and number, and absorption is stopped; the secretion is first morbid, then diminished, and finally arrested; masses of inspissated mucus mingled with shreds of fibrin cling to the tympanic walls and the ossicles; the cavity becomes unnaturally dry, and the movable parts rigid.

This pathological change is not uniform, different parts of the mucosa show different stages of the process, just as the Schneiderian membrane does in chronic nasal catarrh.

The membrane upon the inner surface of the drum-head or over the promontory may be non-secretory, dry and stiff; while in the antrum, and around the entrance of the Eustachian tube, it may show some congestion and secretion.

The pieces of dried mucus plug the mastoid cells, fill depressions, cling to the fenestræ, surround and clog the ossicles, and sometimes remain free in the cavity, to travel about when the patient makes unusual movements.

Two patients suffering with chronic inflammation of the drum reported that they felt something fall in the ear, and had great tinnitus, when they inclined the body forwards. Another had increase of tinnitus and a stopped feeling in the ear after a sudden jar, as in making a misstep, which symptoms were relieved by bending the body forward as in a Turkish salaam. Some patients have heard better when lying down; others in the erect position, probably from displacement of mucus. These mucous masses must necessarily interfere considerably with the proper action of the auditory apparatus, and the hearing will be made variable or very defective, according to their quantity and location.

In rare cases, blood is extravasated into the tympanum spontaneously in diphtheria and Bright's disease, and, as a result of strangulation, vomiting, and violent coughing. It appears through the drum-head bluish-red or black, and may change its level, as the head is bent forwards or backwards. If it does not cause purulent inflammation and rupture of the membrana tympani, it may be reabsorbed, or form a dry clot of obstruction, and produce the same trouble as a mass of mucus.

Adhesions occur between the membrana tympani and the long process of the incus, the stapes, and the inner wall of the tympanum.

num; the anterior half of the tympanic cavity may be separated from the posterior, the upper from the lower, forming cystic spaces. Narrow tympana are especially subject to such adhesions. Firm grayish-white threads and bands of connective tissue are developed between mucous surfaces, and extend from the drum-head to the walls and the ossicles. They result from inflammation of the mucous membrane, the organization of blood clots, and the retrogression of mucous tissue, which normal in foetal life, sometimes remains unabsorbed after birth. The handle of the malleus is often bound to the promontory; the long process of the incus to the posterior wall; an arm of the stapes to the border of the oval window, and the tendon of the tensor tympani to the roof.

A thick fibrous membrane may cover the walls, obliterate the foramen rotundum, close the Eustachian tube and antrum, and, even, fill the whole middle ear with dense fibrous tissue.

Toynbee found these adventitious bands in twenty per cent. of cases examined. The position of these growths determines the impairment of hearing; upon the stapes and vibrating membranes, they are much more injurious than upon other parts.

Atrophy may be produced by inflation, and by senile changes, bands may become threads, a thread may pull away from the drum-head and leave a perforation.

Progressive hypertrophy may go on, favored by the exuberant life of youth and middle age, and by exacerbations of tympanic inflammation. Like all such pathological new formations, these are subject to fatty degeneration, sclerosis, contraction, calcification, and ossification.

The tensor tympani muscle is often shortened, its muscular fibres become fatty, fibrous or absorbed, and its tendon surrounded by a thickened sheath, generally bound to the walls or ossicles by bands or fibres, thus preventing action.

Deposition of lime salts in the membrana tympani frequently coexists with hyperostosis of the external auditory canal, the ossicles, walls of the Eustachian tube and tympanum, and cells of the mastoid process.

The ossicles become displaced by the adhesions and contractions of the membrana tympani, the mucous membrane, and the fibrous

bands. The malleus and incus are sometimes united to the roof of the ear by ossification.

The capsule of the incudo-stapedial articulation relaxes occasionally, the incus is pushed aside, and the articular surface of the stapes is seen with the drum-head drawn tightly over it. Its foot-plate may be at the same time fixed immovably in the oval window by osseous deposits, especially, in old age; and hyperostosis of the base cause a projection into the vestibule. After synostosis has existed a long time, the crura atrophy and become very fragile.

The malleo-incudal and incudo-stapedial articulations become rigid, owing to thickening and calcification of the capsules and surrounding tissue, and the consolidated chain represents the columella, a single bone that performs the functions of a chain, between the membrana tympani and the vestibule in the ears of Saurians.

Hyperostosis due to periostitis occurs frequently upon the ossicles and walls of the tympanum, and osseous bridges extend from part to part, and greatly hinder the transmission of vibrations. The pyramidal eminence may be connected with the foramen ovale; the crura of the stapes with the edges of the vestibular foramina, and the foot-plate with the promontory. The foramen rotundum is sometimes closed to a mere slit by hyperostosis of the tympanic wall, and the mastoid cells are encroached upon and often filled by a new growth of bone, which is sometimes so dense, that it is designated eburnation, or ivory exostosis.

In calcification, the lime salts are deposited in granular masses in the meshes of the true and false connective tissue; in ossification, lamellæ and spiculæ of bone are found in the same tissues, rather nearer the bone; while in hyperostosis and exostosis the development is beneath the connective tissue and upon the surface of the bone.

Diagnosis and prognosis are not difficult in this disease. The instruments and methods of examination of the ear, throat, pharynx, and nose have been already described. Careful consideration of the pathological changes apparent to the eye, of the results of inflation and catheterization, and of the subjective symptoms elicited from the patient, will enable the student of aural disease

to form a tolerably correct opinion of the macroscopic appearance in the tympanum and tube, and to make a true diagnosis. Steaming the ear through the catheter a few times, and using the air-bag awhile will bring early improvement, if the membranes of the fenestræ of the labyrinth are not affected. If no improvement follows, they are thickened or covered over, and amelioration of the hearing will be doubtful.

When the naso-pharynx can be brought to a tolerably healthy state, and its excessive secretion reduced nearly to the normal amount; if relaxed and paretic muscles can be restored to a fair degree of activity, and no organic obstructions exist; inflammation of the Eustachian tube may be lessened or cured, and disease in the tympanum greatly diminished, and, in many cases, permanently arrested.

The prognosis is, however, much influenced by the age of the patient and stage of the disease. In childhood and youth, the prospects are much more favorable than in the middle and declining periods of life. The trouble is, that patients delay applying for treatment for years, and then such alterations in tissue and function have occurred, that no power short of miraculous can restore them to useful hearing. Prolonged treatment in cases where the membrane is not much distorted, and the Eustachian tube is pervious, frequently accomplishes wonders; and this should encourage both patient and physician to a faithful trial of all the means, which the careful study of aural disease has indorsed of late years as scientific and rational.

General Treatment of Chronic Inflammation of the Tube and Tympanum.—It is best, by questioning the patient categorically, to get as complete a history as possible of hereditary tendencies, the previous and present condition of health, and the existence of any diathesis or dyscrasia.

Record a succinct account of the onset and progress of the affection in the ear and associate parts, and try to determine the cause or causes of it. Get all the subjective symptoms in proper order, proceeding from the external ear, through the tympanum and tube, to the pharynx, throat, and nose. Then make a careful examination of the functions and pathological conditions, which will indicate the course of treatment to be pursued.

The best endeavors have often failed to improve the hearing in aural disease, because the diagnosis has lacked precision, and catarrhal and proliferative cases have been treated just alike.

The general health of the patient should be made as nearly perfect as possible by careful regulation of the bodily functions and the personal and domestic hygiene, and by avoidance of those things, acts, and exposures, which are known to aggravate the aural disorder.

The patient must have wholesome food at proper intervals, frequent baths, comfortable clothing, daily exercise out of doors, sufficient regular sleep in a well-ventilated room, and a comparatively healthy occupation. The hair should rarely be wet, and never in cold weather; water and soapsuds must be kept from entering the external canal during washing; a wet towel over the finger will clean the meatus sufficiently; no cotton, wool or other substance should be kept persistently in the ear to protect from cold; ear-laps, mufflers, etc., may be worn if necessary; oil, glycerine, laudanum, ear-drops and other domestic remedies for itching and aching ought to be tabooed; the clothing should be loose about the neck, and a bald head kept covered from the cold.

Respiration through the mouth; the use of tobacco, strong liquors and condiments; exposure to continuous loud noises and explosions, to drafts, cold winds, sudden changes of temperature, and impure air should be avoided.

Intense mental application congests the head and aggravates aural disease, and long-continued exercise of the auditory power brings exhaustion to the tympanic muscles and the auditory nerve, and both should be prevented.

The causes of the morbid condition should be removed when possible; the external may not be discoverable or operative; the internal may be simply local, in the nose, pharynx and throat; or constitutional, consisting of diathetic conditions, embraced in struma, rheumatism, gout, malarial poisoning, and syphilis.

As external causes should be removed when discoverable, so these dyscrasiæ, upon which many cases of chronic inflammation of the tympanum depend, ought to be taken into consideration when one prescribes for the aural disease.

Very frequently the symptoms of the ear and throat are so

few and unimportant, that the physician would be at a loss what medicine to give, did he not consider disturbances and indications in the general system.

Again the aural symptoms may be the only ones that can be perceived upon the most searching examination, but our knowledge of therapeutics as applied to the ear is now considerable, and is being increased continually by contributions from thoroughly educated specialists, so that only the ignorant and lazy grope in darkness. Special treatment will be found upon page 419 *et seq.*

Treatment of Coryza, and influenza, or epidemic catarrh, must now be considered. When the patient is seen early, order a hot foot-bath and frequent libations of hot lemonade, containing or not a teaspoonful or two of whiskey, and confine him to a warm room if possible. The diet should be mild and nourishing, such as oatmeal porridge, boiled rice, milk toast and jelly, milk, beef-tea, eggs, and oysters.

Camphor may be given very early in the affection, but generally the disease is fully under way before the patient applies for treatment.

Aconite is the remedy *par excellence*, and should be given in water every half hour or every hour, until amelioration occurs, or the dry irritable condition of the mucous membrane, the sneezing and oppression of the head, the chilliness and flushes of heat or continuous fever pass away, as copious secretion is established. The patient should snuff up or douche the nose frequently with water heated to 100° F., and containing a tablespoonful of glycerine and an even teaspoonful of salt to the pint. Ten drops of Camphor tincture (*Tr. Camphoræ*) to an ounce of water is, also, an excellent stimulant for this condition.

If the pharynx is, also, affected, gargle the throat with the salt solution, holding the head back horizontally so that the fluid will reach up behind the palate. Some persons can gargle so well, that they can eject the fluid from the nose.

When the Eustachian tube gives symptoms of obstruction or involvement, inflate gently with the air-bag once or twice daily. After the sero-mucus diminishes somewhat, I stop the salt solution and spray the nose and pharynx with a teaspoonful of Tar

tincture (*Tr. Picis liquidæ*) in one or two ounces of warm water. This stimulates the relaxed vessels, and favors their return to a normal calibre.

In my experience, solutions of Quinine (*Quinia Sulphas*), and Carbolic acid (*Acid. Carbolicum*) have had little beneficial influence upon the catarrhal process in coryza or hay fever.

Children are often rebellious to treatment with douche or spray, but may be coaxed to breathe steam from one of the above solutions, heated and exposed in a partially covered bowl. Smokers derive comfort from using cubeb cigarettes, but tobacco is too irritating and debilitating, and should be forbidden.

Belladonna may be required early in some few cases, and in a transient phase of coryza or influenza; especially, if the pharynx and bronchial tubes are involved in the disease. Congestion to the head and face, hot moist skin, sore, raw feeling in the nose and throat, and oppression of the chest, call for its administration.

Arsenicum is a remedy that comes next to Aconite in efficiency. The symptoms lack the fever of Aconite. There is frontal headache and fulness of the frontal sinuses; a copious, watery, excoxiating secretion from the nose and eyes; hoarseness, debility, rapid pulse, restlessness, night exacerbations, and relief from warmth.

Natrum arsenicosum covers very much the same group of symptoms, and has a perfectly reliable pathogenesis made by provers in Allegheny County, Pa., who to this day suffer from their heroic self-sacrificing efforts to give a true picture of drug-action to the profession.

Allium cepa is a favorite remedy for acute catarrh. The distinctive symptoms demanding it are: headache and pain about the temples; profuse lachrymation of a non-irritating character; a little smarting of the eyelids; an acrid discharge from the nose, with violent sneezing; pain in the larynx; hoarse, rough cough; aggravation in a warm room, and amelioration in the open air.

Euphrasia is suitable, when there is photophobia, pressure and burning in the eyes, red, swollen eyelids, scalding lachrymation, a copious flow of bland serum from the nose, frequent sneezing

and coughing, hoarseness and profuse expectoration, aggravation at night, and in a recumbent position.

Eupatorium is an old reliable domestic remedy, much used in decoction of the herb for catarrhs, aching over the whole body, and the general symptoms of a cold. In tincture, it acts finely in mild cases, and should not be neglected. The characteristic symptoms are: soreness of the eyeballs, headache, weight in the occiput, coryza and sneezing, hoarseness, cough, chilliness, and fever.

Rumex is highly recommended in headache, dull aching of the eyeballs, fluent coryza, sneezing, raw feeling in the nose and throat, dryness of the naso-pharynx, mucous expectoration, hoarseness, rawness and pain in the larynx, tickling fatiguing cough, sensitiveness in the open air, aggravation at night, on lying down, and in raw cold weather.

Kali hydriod. should be tried, when there is headache, fulness at the root of the nose, conjunctivitis, a steady flow of acrid secretion from the nose, frequent and violent sneezing, general chilliness, soreness of the nose, a frequent stopped feeling of the nose, roughness of the throat and larynx with dry cough, rattling in the Eustachian tubes, fugitive pains in the joints, and a strumous, rheumatic or gouty tendency. I have found *Kali bichromicum* more suitable for the advanced stage of this disease.

Mercurius is one of the most useful medicines for the later stages of the affection. It should be selected for frontal headache, soreness of the nasal bones, conjunctivitis with excoriating lachrymation and photophobia; a moderate corrosive sero-mucous discharge from the nose, much sneezing, epistaxis at night, relaxation and sponginess of the Schneiderian mucous membrane; dry sore throat with sticking pains, tinnitus, râles in the Eustachian tubes, and deafness; a slimy tongue and mouth, general weakness, and profuse sour sweat at night. In both strumous and syphilitic cases, it sometimes improves the condition of the patient in a short time.

Hepar, *Mezereum*, Nitric acid, *Sanguinaria*, and a few other remedies are occasionally useful in the disease under consideration.

Epidemic influenza requires no different treatment in the early

stages. Its principal symptoms correspond with those of coryza. The patient should have rest from all business care, a mild easily digested diet, and the medicine indicated by the important symptoms.

The medicines that have had a salutary effect upon the morbid process are, Aconite, Arsenicum album, Bryonia, Natrum arsenicosum, Kali hydriod., Magnesia sulphate, Nux vomica, Phosphorus, Rhus, and Veratrum. Some medicines that are beneficial one season are of no use the next.

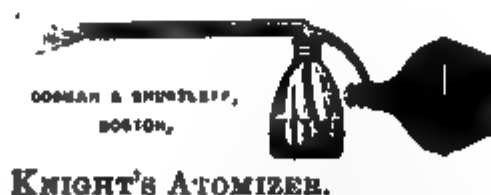
Treatment of Acute Pharyngitis, or common sore throat, varies with the parts affected. In the beginning, a hot foot-bath, lem-

FIG. 84.

PERFUME ATOMIZER.

onade, etc., should be ordered; the neck surrounded with flannel; the throat gargled or sprayed every hour or two with a warm aqueous solution of Kali mur. (*Potassii chloras* grs. xvi, *Aqua* f℥j), and Aconite or Belladonna administered internally.

FIG. 85.



Of all topical remedies, a warm solution of chlorate of potassium is the best. It diminishes the congestion and heat, moistens the parts, dissolves thickened mucus, and acts as an antiseptic. It will greatly diminish the danger in diphtheria, and if used early enough will generally abort the disease. The solution can be applied to the parts very effectually by an atomizer.

The Perfume Atomizer is a cheap instrument with metal tubes suitable to put in the hands of the patient or nurse. Knight's Atomizer is a very useful office instrument, having metal tubes for spraying the buccal pharynx and nose. Newman's Atomizer

FIG. 86.



RICHARDSON'S ATOMIZER.

FIG. 87.



REVERSIBLE ATOMIZER.

is a very good one. The Reversible Atomizer is firmly connected in all its parts, which are made of metal, and currents can be sent upward, downward, and laterally, without removing the tube from the throat. Richardson's reversible jet apparatus, with

FIG. 88.

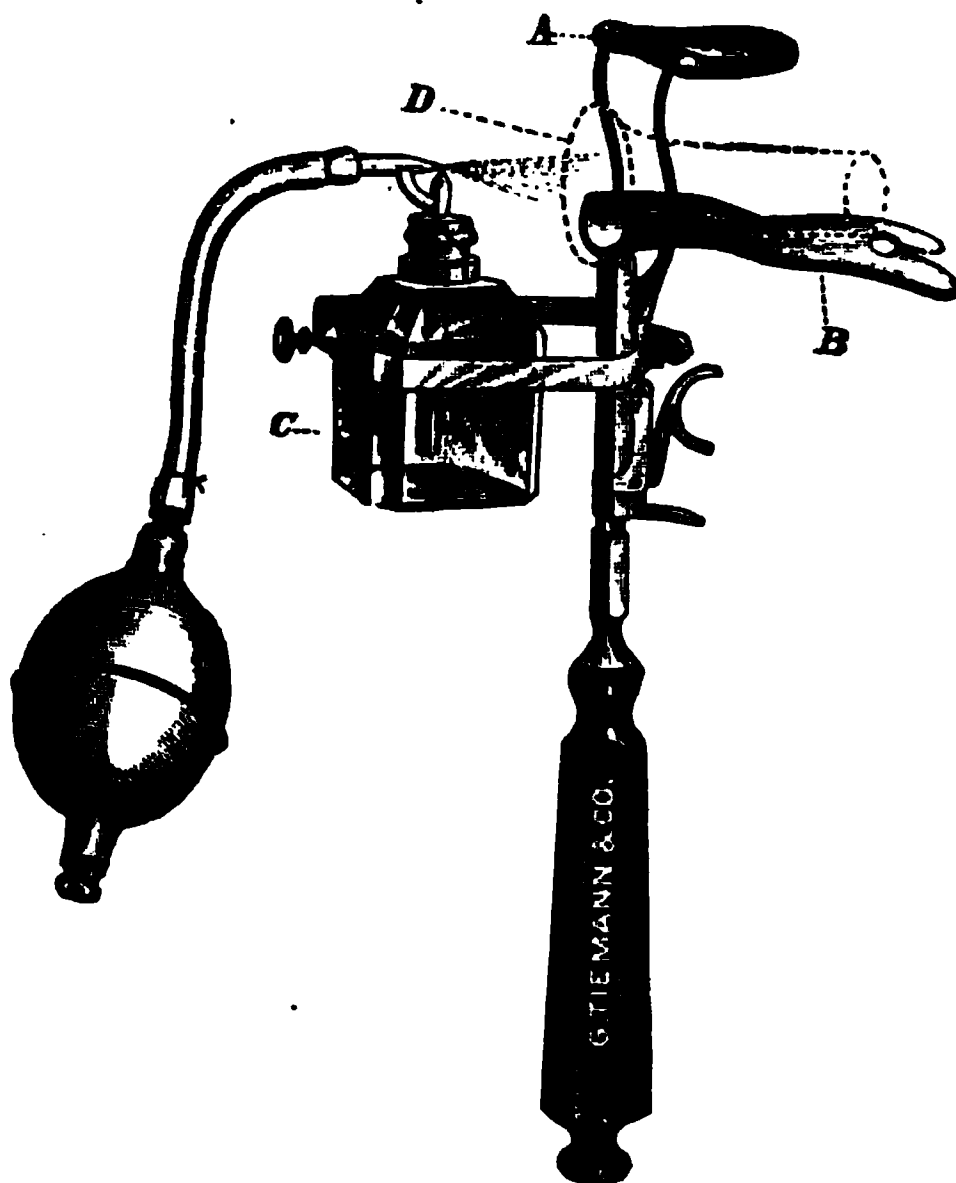
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NEWMAN'S ATOMIZER.

hard rubber tubes, has reversible currents, and is not injured by medicated solutions. It is the most generally useful of any figured and is not very expensive.

The hand atomizers have one or two rubber bulbs, connected by rubber tubing with the base of a tube which helps form the atomizing apparatus. When either rubber bulb is compressed, air is forced along the tube across the capillary point of another tube, producing a partial vacuum therein. The fluid having been introduced into the bottle, rushes up and along this second tube, escapes at the point, is broken into a fine spray, and driven onward by the current of air. When the bulb near the bottle is compressed, an interrupted, when the farther one, a continuous spray is produced.

FIG. 89.



CLEBORNE'S TONGUE SPATULA AND SPRAY APPARATUS.

This combined tongue depressor and atomizer, lately invented by a distinguished naval surgeon, is admirably adapted to keep the mouth open, the tongue down, and the spray in the proper direction. The reversible atomizer can be fixed in the bottle, and then the spray can be used more effectually. The steam atomizer has glass atomizing tubes, and the steam from its boiler takes the place of the air current. It is better to use this in the

earlier stages of acute disease, and when false membranes are to be detached.

Medicines in solution are introduced into the bottle of the hand atomizer, and into a cup upon the side of the steam apparatus. Those containing gums and resins soon clog the fine tubes.

FIG. 90.

STEAM ATOMIZER.

The fluid should be above the lower end of the tube within the bottle or cup. The capillary points should be directed towards the surface to be medicated, and the preferred bulb compressed firmly. The application must be interrupted frequently, in spraying the nose and throat, in order to give the patient a chance to breathe.

Pass the atomizer tube first into one nostril, and then the other, and spray the naso-pharynx; then have the mouth well opened, hold the tongue down with a tongue depressor, and spray the buccal pharynx and throat above and below. Quite young children, handled gently, will endure this method, when they are incapable of gargling, and will not submit to the steam atomizer.

The steam atomizer may sometimes be employed, but its usual tube must be changed for larger ones, in order to spray the naso-pharynx.

In mild cases, a solution of Borax (*Sodii biboras* gr. v, *Aqua* f℥j) is a soothing and efficient spray or gargle. Powders of the first decimal trituration of *Kali murias* are a good local remedy, and may be given with directions to let each powder dissolve upon the tongue, and then swallow slowly.

Chlorate of potash lozenges may be used in the same way, and an infant will take a quarter or half of one, now and then, with much benefit to the throat. Potash salts are antiplastic; when absorbed into the blood, they diminish fibrinogenous elements, favor free exudation in mucous membranes, and diminish the tendency to plastic deposits.

Tannic acid is frequently used in spray, and as a gargle. A drachm of the powder, dissolved in an ounce of glycerine and three ounces of water, makes a topical application of value in relaxed mucous membranes and oedema of the uvula, after the acute inflammation has somewhat subsided. Lactic acid in solution (*Acid. Lacticum* gr. xx, *Aqua* f ʒj) is an excellent local application in diphtheria, and diluted Chlorine water (*Aqua Chlorini* f ʒj, *Aqua* f ʒj) has been much lauded in the same disease. Vapor of lime-water, inhaled from a vessel as lime is slacking, often proves effectual in expelling false membrane.

Water containing Alcohol, Capsicum, Carbolic acid, Alum, Sulphate of zinc, Sulphate of copper, etc., are recommended by authors, but are less efficacious than those remedies mentioned above, and some of them are decidedly objectionable on account of their effects upon the teeth and the general system.

I use the sprays quite warm, and order the gargles to be taken in the same way, when possible. Cold solutions, however, do very well, and are often preferred by patients.

It will frequently be necessary to combine the local treatment for coryza, with that of acute pharyngitis, especially, the use of a warm medicated solution by snuffing, or by the nasal douche. A slight fulness in the ears, an unusual resonance of sound when speaking, and rattling of mucus in the Eustachian tubes when blowing the nose, indicate the necessity of gentle inflation. This should be done as often as the symptoms recur, but probably once or twice a day will prove sufficient.

Aconite is useful at the onset of the disease to reduce the general fever, and diminish the congestion of the throat. Chilliness, followed by decided fever, restlessness and anxiety; painful deglutition; burning, stinging pain in the throat, neck and ear; crimson color of the fauces and pharynx; swollen tonsils, and full feeling in the throat, call for its use.

Apis is given for dryness, burning and stinging in the throat, sense of constriction, difficult swallowing, swollen or ulcerated tonsils, cedematous swelling of the throat and neck, and engorgement of the submaxillary glands.

Acid. Nitricum is a most excellent remedy in diphtheria of the throat, with rawness of the nose, livid swelling of the throat, great tumefaction of the tonsils and submaxillary glands, large formation of false membrane, and a fetid, gray, slimy discharge from the throat and nose.

Pulsatilla suits mild cases of sore throat, with implication of the Eustachian tubes and ears, in children and persons of strumous and lymphatic constitutions.

The inflammation of the mucous membrane in such patients, results in an early and copious flow of sero-mucus, and resolution follows soon, or a chronic disorder of a mild character remains.

Belladonna is a specific for many cases of sore throat, and most benefit is derived from its use in the early stages of the disease. After forty-eight hours, another remedy will generally be found to suit the case better. It relieves the pain and swelling of pharyngitis and tonsillitis sometimes in a surprising manner. A lady had quinsy, the throat was nearly closed, both tonsils immensely swollen, only a few drops of water could be swallowed at a time, constitutional disturbance was great, and the patient much alarmed. *Belladonna* internally for twenty-four hours had not relieved. I continued the medicine, but supplemented it by a two-inch wide *Belladonna* plaster, extending over the tonsils from ear to ear. Relief without suppuration came in twelve hours and restoration to health soon followed without any other medicine.

The symptoms demanding this medicine are: active congestion of the head; hot, moist skin; soreness, fulness and constriction in the throat; painful swallowing with frequent inclination; throat dry, rough, burning, bright red, swollen and painful; tonsils and submaxillary glands often swollen; sharp pains through the throat and Eustachian tube, especially when swallowing; the neck sensitive to touch, and the ears frequently affected by fulness, tinnitus, deafness and pain.

Mercurius stands next in efficiency, if it does not alphabetically, particularly, if the patient has syphilis. It is indicated when there

is malaise, indigestion, disturbance of nutrition, and weakness; the breath is fetid and offensive; the tongue is pallid and swollen; there is a slimy secretion in the mouth and fauces; the mucous membrane of the fauces and pharynx is deep red, sore, swollen and ulcerated; false membranes sometimes appear; the uvula is elongated and œdematous; the tonsils are bluish or dark red, tumefied, ulcerated, and the seat of throbbing, stinging pains; the submaxillary glands are engorged; the Eustachian tubes are obstructed; pains shoot through the throat and neck; the larynx is inflamed causing hoarseness, and the neck is painfully sensitive to touch and motion.

These symptoms threaten suppuration of the tonsils or submaxillary glands, and this may be often arrested by steady administration of the medicine for some days. The time for the administration of Mercurius is later than that for Belladonna, possibly after this has failed; and the pain is not so severe as when Belladonna is suitable. The sthenic stage of Belladonna has passed, and asthenia begins to appear in the marked alteration of the secretions and the failure of strength, so commonly seen in provings of Mercury. Mercurius corros. and Mercurius solubilis are good preparations to use, but many practitioners prefer Merc. iod. rub., Merc. oxid. rub., and Merc. cyanid. for throat affections.

Lycopodium is useful only in a limited number of cases. It is given very often, however, for sore throat upon the right side, when the totality of symptoms, and, even, the local ones positively contraindicate it. Among reliable indications for its administration are: confusion of mind, melancholia, vertigo, headache, palpitation of the heart, attacks of dyspnoea, excessive flatulence, irritation of the mucous membranes everywhere, coryza with acrid discharge, hyperæsthesia and noises in the ear; superficial inflammation of the pharynx and fauces, indicated by burning, rawness, pain on swallowing, and tawny redness; moderate swelling of the tonsils, and some soreness to the touch below the angle of the jaw.

Lachesis has a precious list of symptoms, and is thought to have an affinity for the left side of the body, and thus is a sort of antithesis of *Lycopodium*.

I was treating, in 1878, a severe case of diphtheria, with Nitric acid. The nose had improved much, the throat, though better than at first, had been at a standstill for several days. Strength was failing fast. I compared symptoms again, and settled upon the acid, which was continued. The next day the membrane upon the left side had diminished, and a patch had appeared upon the hitherto clean right side. I said to myself, "that's a Lachesis symptom." I concluded to wait another day as the boy seemed a little better, and the other symptoms were not very characteristic between the two medicines. The next day the membrane was gone from the right side, the boy was better, the Nitric acid was continued, and in a short time my patient was well.

If I had changed to Lachesis at the time I saw its peculiar symptom, the boy might have died, or the snake virus have received undeserved credit.

Symptoms which should call attention to Lachesis are: great depression of vital power, gray sickly pallor of the face, mental exhaustion, præcordial distress, palpitation of the heart, oppression of the chest, swelling of the submaxillary glands, neck and throat. The tonsils are livid red, threatening gangrene; sometimes ulceration is already present; there are choking sensations; shooting pains in the throat, extending along the Eustachian tube; tinnitus and pain in the ear; roughness and soreness of the larynx; hoarseness, spasms of the glottis, hacking cough, and great sensitiveness in the neck and larynx to outside pressure. The picture is one of adynamia, and is seen in exanthematous fevers most frequently.

Phytolacca has proved of considerable value in acute pharyngitis, especially, in the early stages, and where the attack is in a rheumatic or syphilitic subject. The symptoms that call for its administration are: general debility, nausea, and severe headache; stiffness and soreness of the muscles; rheumatic and neuralgic pains in various parts of the body; swelling of the lymphatic and other glands, and irritation of the eyes and nose. The tongue is rough and sore on the edges, very red at the tip, with severe pain at the root; the throat feels full, dry, rough and smarting; the soft palate and tonsils are swollen; the mucous

membrane of the throat is dark red, sometimes ulcerated, or there is a dark pseudo-membrane upon it; a thick tenacious saliva fills the fauces, causing hawking and cough; swallowing brings a feeling of a lump in the throat, and severe pain that shoots along the Eustachian tubes through the ears.

Poke-root tea has a good reputation, where the plant is indigenous, for the cure of rheumatism, and the refined medicine prepared for use has a sort of specific influence upon very painful attacks, which are sometimes called rheumatic, sometimes erysipelatous sore throat.

Rhus toxicodendron corresponds with *Phytolacca* in many of its symptoms, and is a precious medicine, rescued from the obscurity into which it had been cast by materia medica authors. One should resort to it, when there is great prostration, chilliness and fever; great restlessness and uneasiness; anxiety, vertigo, and mental disturbance; palpitation of the heart, oppression and soreness of the chest, soreness of the larynx, with hoarseness and cough; paralytic weakness and aching of the limbs; numbness, pricking and trembling sensations; stitching pains and cramps in different parts of the body; stiffness, soreness, and tension of muscles and joints; eczematous and erysipelatous eruptions, especially, upon the face; swelling and suppuration of glands.

The eyes and nose are variously affected; the tongue is sore, red, and sometimes cracked; there is thirst, bad taste, and foul breath; the mouth and throat are dry; the mucous membrane is dark red or bluish purple, turgid with venous blood, and may show ulceration or false membrane; there is swelling of the throat, tonsils, submaxillary glands, and cellular tissue of the neck; the parts are sore and stiff; sharp pains dart through the throat and neck, and swallowing is difficult and very painful. The medicine seems more suitable for diffused sore throat than tonsillitis, and for that particular kind, that occurs in plethoric persons of intemperate habits, with a rheumatic, gouty or syphilitic diathesis.

Kali bichromicum acts powerfully upon the mucous membranes, and is adapted to both acute and chronic pharyngitis. It is indicated by prostration; aching in the bones; fugitive pains; pale face; disorder of the stomach and intestines; oppression of the

chest; hoarseness and cough; conjunctival inflammation; coryza or chronic nasal catarrh; red tongue, coated whitish-yellow at the base; dryness of the mouth; thick, tough, viscid, stringy mucus in the nose, throat, and larynx; fulness, burning and rawness of the throat, extending down the œsophagus; soreness and shooting pains through the tonsils, throat and ear; the mucous membrane is red and tumid, or yellowish-red, relaxed and ulcerated; the tonsils are ulcerated in spots, or red, tumefied and threatening suppuration; ulcers when visible show an uneven yellowish base and red borders; one is struck by the apparent lack of vital reaction against the morbid condition.

Sanguinaria may be of benefit, though its symptoms pertaining to the throat are not very characteristic. Headache, vertigo, tinnitus, pain in the throat and ears; dry, raw throat; fulness and choking sensation while swallowing; inflammation and ulceration of the mucous membrane, with pearly diphtheritic exudations; dry cough and dyspnoea; chilliness and fever, and torpid languor and weakness, are regarded as characteristic symptoms for the employment of the medicine.

Hepar sulph. calc. is of secondary value in the early stages of pharyngitis to some of the medicines already mentioned, but is generally required when suppuration threatens. It should be considered, when there is lassitude, fainting spells, great sensitiveness in the open air, chilly sensations and flushes of heat followed by easy sweating, stitching pains over the body, swelling of the glands, vertigo, and headache. The eyes may be irritated or sore; the nose affected by catarrh, and the larynx, trachea and bronchi inflamed, causing dyspnoea, hoarseness, and harsh cough. The throat has a dry, scraped, sore feeling; the mucous membrane is red and granular or ulcerated; sharp pains shoot through the throat and neck, and extend along the Eustachian tube to the ear; the submaxillary glands are tumefied, and the tonsils swollen. The whole tonsil or the part over the abscess forms a pyramidal or rounded prominence, projecting into the fauces; but sometimes the swelling is very irregular, and the abscess out of sight behind it.

It is desirable to abort a suppuration, or, if this cannot be done, to hasten the process. The former work can be best accomplished

by some of the above remedies ; the latter by the administration of Hepar, which has a specific influence upon the formation of pus.

Incision.—When the tonsil is enormously swollen, the swallowing very difficult or impossible, and suffocative spells frequent, the tonsil ought to be incised in several places, so that it may bleed freely ; but the abscess should be opened by preference in all cases, when possible without too much risk.

A long-handled bistoury, having the blade wound by tape so that only half an inch of the point is uncovered, is safe and efficient for scarification. Seat the patient with the head against a support ; illuminate the throat by direct or reflected light ; depress the tongue, and put a cork between the teeth to hold the jaws apart if necessary ; pass the knife directly backwards, with the cutting edge directed *inwards* upon the affected side ; push the point into the tumor inside the palato-glossus muscle, preferably into the inner half of the swelling, and cut towards the middle line of the body.

Make two or three incisions a little distance apart, or push the knife into an abscess ; then give the patient warm water as a gargle, and let him hold his head forward, so the blood or pus may run out anteriorly. The only danger is of wounding the carotid artery, which courses upwards just at the base of the tonsil. Swelling sometimes displaces the vessel and renders its exact relation to the tonsil doubtful, but, if the above directions are followed, no disaster need be apprehended.

Treatment of Chronic Nasal Catarrh.—This is one of the most obstinate diseases the physician is called upon to treat. In many cases of aural disease, the Schneiderian mucous membrane must be brought to a healthier state, or the ear trouble cannot be removed. The frequent partial as well as total interruption to respiration through the nose, and the almost constant irritation maintained in the naso-pharynx by the morbid discharge, prevent the normal action of the Eustachian tubes in aerating the tympanum, and support the diseased condition of the tubal and tympanic mucous membrane.

Proper treatment of the nose and pharynx will do more good, than neglect of these, and the most thorough measures directed to

the ear. The patient must observe all the hygienic measures, which long observation and experience have shown to be sensible, scientific, and conducive to the best health of man. Everything calculated to cause frequent irritation in the nasal mucous membrane ought to be avoided; therefore, working daily in a dusty atmosphere, using catarrh snuffs, and smoking cubebs and tobacco should be forbidden. In the early stage, a great deal can be done by preventing colds, and treating those that occur gently but persistently. After the mucous membrane has become thickened, atrophied, and ulcerated in places, I think colds in the head are not frequent, exposure being more likely to cause inflammation of the larynx and bronchi. I can only account for this by supposing, that the morbid state of the Schneiderian membrane renders it incapable of those profuse sero-mucous fluxes to which it is so subject when healthy, and, that a moderately increased mucous discharge occurs in the nose from a cold, but the major work of elimination—if cold causes elimination of some morbid product of the blood—is done by healthier mucous membrane in the larynx and bronchi.

When acute attacks have subsided, and the nasal lining keeps up a rather free discharge too long; especially, if the discharge shows a little bloody, or the patient has occasional attacks of epistaxis from slight causes, then is the golden opportunity to nip the affection in the bud. These patients are generally children or adolescents, adults presenting more advanced disease; but occasionally a middle-aged person, who is in feeble health, furnishes evidence of this incipient stage. In the mildest phases, I direct a warm solution of an even teaspoonful of salt to a pint of water to be snuffed well into the nose, and used as a gargle every day.

Pulsatilla is the most valuable remedy in the materia medica for this state, but ought to be given in tincture. If the patient is strumous, or of very light sanguine temperament, Calcarea carb. may be given, but I prefer the Calcarea phos., which in my experience has proved very efficient in all cases where the carbonate seemed indicated.

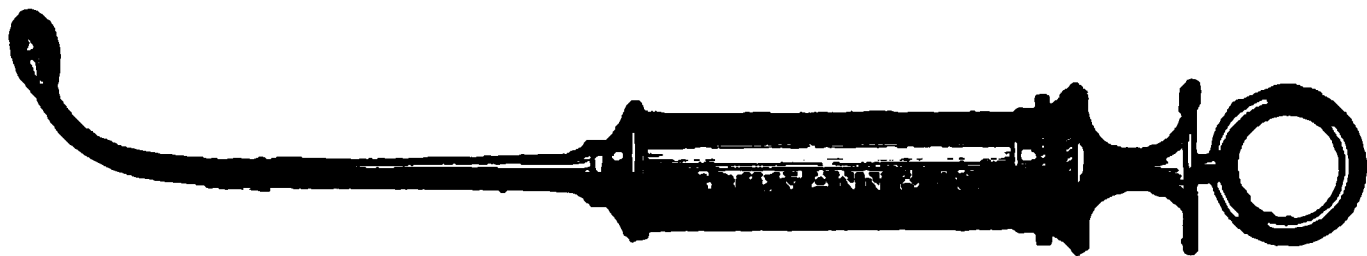
If the symptoms do not improve, it is advisable to give Arsenicum iod., and have the patient, in addition to the usual salt-water douches, draw in the nose twice or three times a week, the steam

from a pint bowl of hot water, in which a teaspoonful of Terebinthina tincture has been diffused. After carefully following this treatment for some weeks, if the catarrh and bloody show still continue, I believe it advisable to spray or douche the nose twice a week with a warm mixture of a teaspoonful of Tar tincture in a pint of salted water.

Generally these measures will restore the integrity of the mucous membrane, but in obstinate cases, besides constitutional medication, it may be necessary to use a spray or douche of five grains of Alumen or of Zinc sulphate to a fluid ounce of warm water, to astringe and tone up the relaxed mucous membrane. These mild cases, which generally precede for awhile the graver ones, are seen by the general practitioner much more frequently than by the specialist; and the former, therefore, should be more interested in prophylaxis against the severe nasal catarrhs.

When chronic nasal catarrh has reached the secondary stage, characterized by thick discharge and some degeneration of the Schneiderian membrane, the most important measure for the comfort of the patient, for improving or curing the disease, and preventing or curing Eustachian tube or middle ear complications, is to keep the nasal labyrinth and naso-pharynx clean and free from

FIG. 91.



POST-NASAL SYRINGE.

the morbid secretions of the parts. At the same time certain local medicaments must be applied *secundum artem*, while the proper internal remedy is taken continuously.

There are several ways of cleansing the nasal meatus. Fluid may be snuffed into the nose from the hollow hand or from a vessel. The patient should be directed to breathe only through the mouth, and to hold it very wide open during the procedure, to prevent washing secretions down the throat.

This method fails to cleanse the devious passages in a thorough

manner, and, hence, is only applicable alone, when the disease is mild, and confined to the inferior and middle meatus of the nose. It is very useful, however, to combine this, in many cases, with injections through each side of the nose from the posterior nares, by means of the post-nasal syringe already mentioned. It is not needed when the douche is employed.

The post-nasal syringe is of hard rubber, has a spool-shaped butt, so that it can be readily held between the index and middle fingers, while the thumb in the ring works the piston. The instrument is operated with one hand, the curved and much-perforated nozzle is passed up and hooked behind the palatine arch of each side in succession, while the tongue is depressed, and the throat is kept in view under direct or reflected light.

When the injections are made, it is well to cover the patient's chest with a long towel, and direct him to incline the head a little

FIG. 92.

THE POSTERIOR NARES, ETC. (Seiler).—1, The nasal septum; 2, inferior meatus; 3, superior meatus; 4, middle meatus; 5, superior turbinated bone; 6, middle turbinated bone; 7, inferior turbinated bone; 8, mouth of Eustachian tube; 9, Rosenmüller's fossa; 10, side of the pharynx; 11, the pharyngeal tonsil; 12, velum of the palate.

forwards, so that the fluid from the nose may run into a vessel, and not over his clothes and the floor. He must be directed to keep his mouth open, and to breathe through it, and be cautioned not to start back when the injection is in progress. If deftly done, the whole fluid drawn up by the syringe and injected, should run out of the anterior naris of the side upon which the injection

has been made. Sometimes owing to contraction of the pharynx and displacement of the nozzle, the fluid will escape from both nostrils.

This is generally the case, when the fluid is injected merely into the naso-pharynx, and indicates the necessity of carrying the nozzle higher, in order to effectually clean both meatuses.

If the reader will note the direction of the turbinated bones, and the passages of the upper portion of the nose, he will see that an injection from behind will pass into places that cannot be reached from the anterior nares except with the douche, and then only when the upper part of the nose is harmoniously developed and the passages large.

The superior meatus of the nose is directed obliquely downward and backward towards the pharynx ; it communicates above with the middle and posterior ethmoidal sinuses, and behind with the sphenoidal sinus. Its anterior communication with the middle meatus is frequently closed by irregularity in osseous development and by disease.

The middle meatus is directed backward and a little downward. The anterior ethmoidal, and the frontal sinuses open into its upper anterior portion, and the maxillary sinus into its middle part beneath the middle turbinated bone.

The inferior meatus below the true turbinated bone is directed horizontally backward, and receives in its anterior portion the lachrymo-nasal duct.

The problem in chronic catarrh is to cleanse and medicate all this labyrinth. It is apparent that fluid introduced by the anterior nares will readily flow into the inferior and middle meatuses, but will pass with difficulty, or not at all, into the superior meatus and its diverticula. It is evident that a stream of fluid thrown forward and upward from behind will reach the superior meatus and its sinuses very easily, and it is because this fact is not remembered, and the post-nasal syringe is not used in conjunction with the douche, that so many cases of chronic nasal catarrh resist treatment. I recommend, therefore, the use of the syringe to cleanse these upper passages, in all but the mildest cases of chronic catarrh, and consider it a *sine quâ non* for severe ones. In conjunction with snuffing and anterior injections, it may suffice and the douche

may be neglected, in cases where the use of the latter is not considered advisable.

FIG. 93.

VERTICAL SECTION OF THE FACE AND NECK (Leidy).—1, Oval cartilage of left nostril; 2, triangular cartilage; 3, line of separation; 4, prolongation of oval cartilage along the nasal column; 5, superior nasal meatus; 6, middle meatus; 7, inferior meatus; 8, sphenoidal sinus; 9, side of posterior naris; 10, mouth of Eustachian tube; 11, naso-pharynx; 12, soft palate and uvula; 13, post-labial region; 14, roof of mouth and hard palate; 15, communication between the bucco-dental space and mouth; 16, tongue; 17, fibrous septum of tongue; 18, genio-glossal muscle; 19, genio-hyoid muscle; 20, mylo-hyoid muscle; 21, anterior half arch of the palate; 22, posterior half arch of the palate; 23, tonsil; 24, 25, floor of the fauces; 26, 27, pharynx; 28, cavity of the larynx; 29, ventricle of the larynx and vocal cords; 30, epiglottis; 31, hyoid bone; 32, 33, thyroid cartilage; 34, thyro-hyoid membrane; 35, 36, cricoid cartilage; 37, sterno-thyroid muscle.

Gruber has given directions for injecting the nose anteriorly, for the purpose of cleansing the naso-pharyngeal space and medicat-

ing the Eustachian tubes. A two-ounce syringe with a rounded nozzle is filled with the fluid desired, pressed into one nostril, and quickly injected. If it is required merely to cleanse the nasopharynx, the other nostril is left open, and the fluid escapes thereby; if to force the fluid into the tubes, it is partially or wholly closed for an instant. No directions are given the patient about breathing, reliance being placed on the instinctive action of the base of the tongue and soft palate to shut off the upper pharynx from the throat. I think the patient should be instructed to keep his mouth well open, and to breathe through it, as I have tried the method of the distinguished professor several times, and instinct failed so ignominiously, that the whole injection went into the stomach.

There is considerable difference of opinion among authors in regard to the advisability of using the nasal douche. From observation and experience, I am inclined to the belief, that the instrument is not injurious to the ear when used in a proper manner. I have known many cases of naso-pharyngeal catarrh treated by the douche, without injury to the ears, even when diseased, and I use it frequently in my practice with the best results.

There are several kinds of douche, in the market, but I shall allude to only two, the siphon, and the modified Thudicum douches.

The siphon douche consists of a piece of simple rubber tubing, fitted with a good sized nipple or olive-shaped, hollow nose-piece at one end, and a perforated, hemispherical, nickel-plated weight at the other. The base of the latter has an elevated scalloped rim around the circumference, so that when it rests base downwards, the fluid can flow freely to the central hole, which communicates with the tube upon the upper side. Any vessel, preferably a pint tincup, completes the apparatus.

The vessel should be filled with the desired solution; then put the instrument into it until the tube is filled, close the nose-piece tightly with the finger, and remove all of the tube except enough to leave the weight upon the bottom of the receptacle, and it is ready for use.

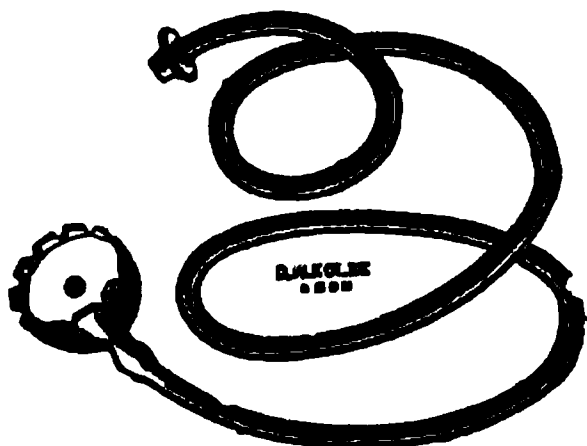
The modified Thudicum douche, as recommended by Dr. Seiler,

consists of a nose-piece and length of rubber tubing, connected with a pint tincup by a tube soldered into a hole near the bottom. When fluid is placed in the cup, and the tube is held below, the flow from the nose-piece immediately begins.

A tincup is preferable to a crockery or glass bowl, because it will not break, and is inexpensive. I prefer the siphon apparatus and a glass bowl, however, for medicated solutions, as the tin becomes oxidized and the iron rusty from the chemical action of certain remedies.

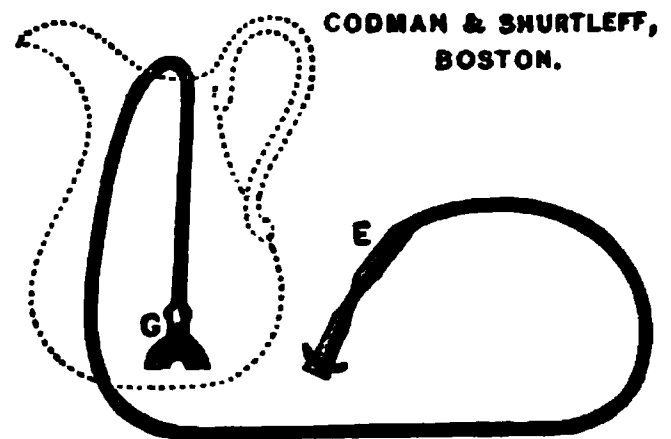
The physician before applying the nasal douche should note if the patient can breathe freely through both sides of the nose, and

FIG. 94.



SIPHON DOUCHE.

FIG. 95.



SIPHON DOUCHE COMPLETE.

examine both nasal fossæ anterior and posterior, to be certain there is no obstruction sufficient to prevent the flow of fluid both ways.

If obstruction is found, the douche should not be tried. If no obstacle exists, he should then instruct the patient to breathe through his mouth, keep this wide open, and incline his head a very little forwards above a receptacle. The clothes should be covered with a towel or rubber apron, and the patient encouraged to keep quiet and obey orders.

The solution having been prepared and put in the cup, the nose-piece is pushed into the nostril and held so as to close it, the patient cautioned to watch his breathing, and the cup steadily raised till its bottom is upon a level with the eyebrows. As the fluid flows through the meatus, around the naso-pharynx and septum, and out of the other nostril, and the patient gets accustomed to the new sensations, the cup may be elevated one or two inches higher; but under no circumstances should it be raised above the

head, as the increased pressure will force the fluid into the Eustachian tubes, frontal sinuses, and even farther, and produce serious consequences.

The first application should be short, and half a pint of fluid is sufficient for it. The quantity may be increased, as the patient becomes accustomed to the treatment, until a pint or more is passed through the circuit. The patient may be instructed how to use the douche by one or two office applications, and then cleansing and topical medicinal treatment may be carried on by him at home; the physician, however, should not remit his attentions on this account, but use the instrument upon the patient several times a week, in conjunction with the posterior nasal syringe, in order to insure thorough work.

All fluids introduced into the nose ought to be raised to a temperature agreeable to the patient. This will be a little below blood heat, and may be approximately determined by dipping the back of the hand in the solution, or putting a few drops in the palm. The first filling of the syringe or douche should be wasted, especially in cold weather, as its heat is abstracted by the cold instrument.

Another important matter is the specific gravity of the fluid. Simple warm water as advised by many persons is positively injurious to the nasal mucous membrane. The douche must be of the same density as the serum of the blood, or osmotic effects will be produced.

When warm water, or a fluid of less density than the blood serum, is brought in contact with the nasal lining, endosmosis will take place, the numerous capillaries will become engorged, and pain induced.

When a fluid of greater density than the blood serum is employed, exosmosis will occur, the blood corpuscles, deprived of part of the liquor sanguinis in which they float, will accumulate and stagnate in the capillaries, and cause irritation and burning pain.

A solution of 56 grains of common table salt in a pint of water will neither swell nor crenate the red blood corpuscles, and is, therefore, of the same density as the blood serum. This property, and the well-known antiseptic nature of chloride of sodium,

render this liquid excellent for cleaning purposes, and it may be used as a vehicle for medicinal substances with which it is not chemically incompatible. In such instances, the quantity of salt must be diminished in proportion, as other substances are added, in order to preserve a specific gravity of 1030.

The solution may be made near enough for practical purposes by adding an even teaspoonful of table salt to a pint of warm water. Sea salt, sold by druggists for bathing purposes, is agreeable for nasal applications, and may be substituted for the common article.

After warm douches and warm spraying, a patient ought not to go out of doors for some time, especially, in the cold season; and in all seasons he should be careful of exposure to drafts and damp places. I have seen sweat stand in great beads upon the forehead after a moderately warm nasal douche, and one of my patients took a severe cold from making a call soon after an application, having been obliged to stand some minutes waiting at the door for a lazy servant to let him in.

The post-nasal syringe and the nasal douche are to be used with the salt solution to cleanse the nose and pharynx whenever required. It may be necessary at first to do this twice a day, but once daily is generally sufficient. The patient must co-operate in the treatment by blowing the nose hard, and by taking forced nasal inhalations, in order to remove all morbid secretions. A good deal of trouble is necessary occasionally, particularly when the patient is first seen, to dislodge the foul crusts and scabs, which cling to the narrow passages of the nose; but by repeated snuffing, blowing, syringing, and douching success is gained, and if proper measures are adopted, they will not accumulate in quantity again.

Inflation with the air-bag aids in clearing the passages, and will often remove the dreadful frontal headache that comes from stuffed sinuses.

After the nasal passages are clear and clean, it is desirable at least once a day to apply antiseptic and medicinal solutions to the mucous membrane. This may be done with the syringe, douche or atomizer. One of the best lotions after cleansing is a warm solution of Muriate of ammonium (*Ammonii murias* ℥ij, *Aqua* Oj),

applied with the post-nasal syringe, or by the hand atomizer through the nostrils and the throat. The same solution may be injected through the catheter into the Eustachian tubes, if they are much affected. Borax, bicarbonate of sodium, and chlorate of potassium are used in the same proportion, and are nearly as efficient.

If there is ulceration and a very foul odor to the discharge, Chlorine water (*Aq. Chlorini*), one tablespoonful to a pint of warm water, sprayed into the pharynx and nasal fossæ, will prove valuable. The dilution may be used often as a gargle, when the throat is foul and diseased, as in diphtheria and malignant scarlatina. It deodorizes and disinfects the morbid exudates and the mucous membrane, and stimulates the tissues towards healthy action.

A solution of Permanganate of potassium (*Potassii permanganas* gr. x to xx, *Aqua* f℥j) is antiseptic and mildly stimulating, and may often be used with advantage.

Severe cases of chronic catarrh, denominated Ozæna, sometimes have a sickening smell, and require a stronger deodorizing, disinfecting, and stimulating remedy. This is found in Carbolic acid, which should be used as a spray and gargle in the proportion of five grains to the fluid ounce of water. A teaspoonful of glycerine added to the solution will make it more agreeable and more effective, especially, when the crusts and certain parts of the Schneiderian membrane are rather dry, and the former cling tenaciously.

Many practitioners may be content to rest the local treatment here, keeping the nasal fossæ and pharynx scrupulously clean and sweet, and relying upon the *vis medicatrix naturæ* and internal medication to effect a cure. Some patients may recover after awhile; others will be greatly improved, but will need astringent and stimulating applications applied to the naso-pharyngeal mucous membrane.

Tannic acid, commonly called tannin, is a pure astringent, having stimulating or irritant properties according to the strength of the solution of it employed. It is much superior to *Hydrastis* and *Hamamelis* for topical use, as these contain deleterious vegetable matters mixed with the tannic acid upon which their value depends.

The mucous membrane of the nose and pharynx, in the very humid cases of chronic catarrh, becomes relaxed and œdematous, upon the anterior and posterior ends of the inferior turbinated bones, it is soft, moist, glistening, swollen, and bags downwards, so that it is sometimes difficult to differentiate the cushions from mucous polypi.

This condition is generally coincident with elongated uvula, low-drooping arches of the palate, and hypertrophic pharyngitis. A solution of tannin (*Acid. Tannici* gr. xx to xxx, *Aqua dest.* f3j), applied to the parts with the atomizer, sometimes supplemented by the post-nasal syringe, contracts the distended capillaries, promotes absorption of the submucous effusion, and stimulates to healthy action.

This solution is excellent for mild cases of epistaxis, occurring during the course of the disease.

Tannin in glycerine is much employed in throat practice, and is frequently beneficial, but should not be used for the above symptoms. The aqueous solution is better adapted to the conditions, and it suits sore throat in general better than the glycerite.

Sulphate of zinc is preferable to tannin, when there is no hemorrhage, and rather more stimulation is desirable. It may be employed for the œdematous symptoms of nasal catarrh, as well as for an atonic, granular, and ulcerated state of the Schneiderian membrane. When cleansing and the above applications seem to have done all the good they will, and the mucous lining appears here pale, there red and rough, perhaps, in another place showing shallow, broad ulceration, a zinc solution (*Zinci Sulphas* gr. x to xx, *Aqua dest.* f3j), applied twice or three times a week, awakens the dormant energy of the tissues and promotes healthier action.

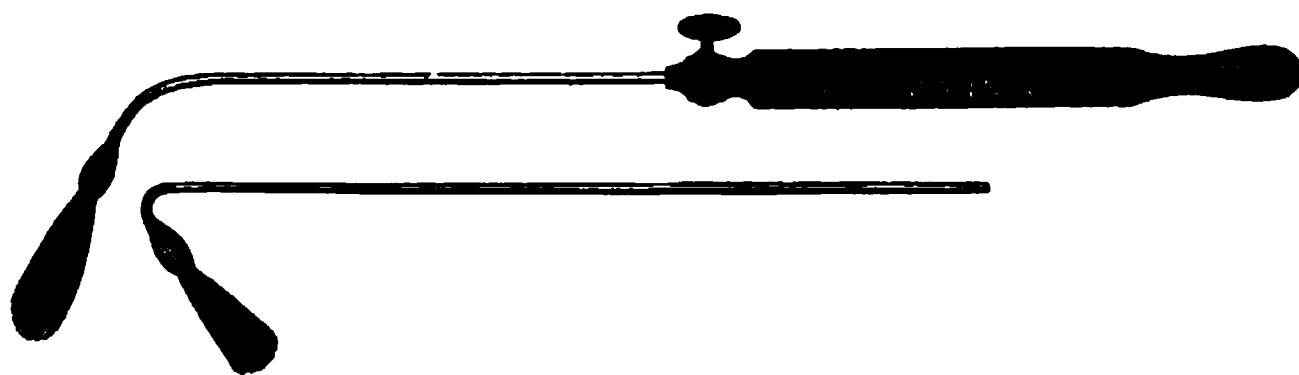
The tar-water before mentioned is a mild and agreeable stimulant, that may be used alone or in alternation with an astringent remedy. It can be added to the officinal salt solution for daily cleansing purposes with advantage. If the mucous membrane is very dry, a dressing of equal parts of glycerine and water is demanded. Glycerine may be added to some of the medicated solutions when deemed advisable.

Nitrate of silver is a better topical application for this disease than anything yet discovered. It suits all the stages admirably. It is soothing and antiphlogistic to active inflammation; it astringes and tones up relaxation, causing vessels to contract and resume their wonted activity; it burns a superficial slough upon spots of ulceration, and exercises a mysterious alterative power over tissues morbidly astray; it starts all the parts into active nutritive change, which, aided and guided, will lead to a condition so closely approximating health, that both patient and physician will be satisfied.

For general stimulating, astringing, and alterative purposes, a five or ten grain solution of nitrate of silver (*Argent. nit. gr. v to x, Aqua dest. f3j*), should be sprayed into the anterior and posterior nares every second or third day, according to the severity of the case, after the parts have been thoroughly cleansed, and a last wash of Sodium bicarbonate has been used.

Solutions of twenty, thirty or forty grains to the ounce of water may be applied by a camel-hair brush, a special flexible throat-brush, a light tuft of cotton on the holder, or, rarely, by a small bit of sponge in a sponge-holder. These strengths stimulate strongly, and cauterize tender spots and ulcers superficially.

FIG. 96.



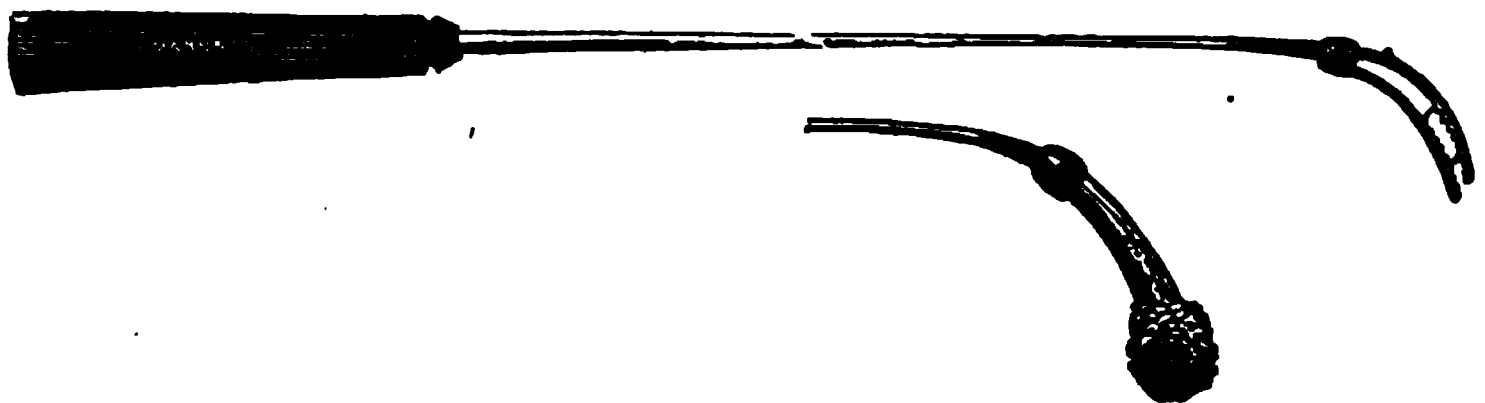
WAGNER'S HANDLE AND BRUSHES.

If it is desired to apply the solid caustic, melt some crystals of the pure salt in a little porcelain capsule or a platinum cup such as is used in chemistry and metallurgy, dip into it when melted the end of a flexible silver probe, then withdraw it and let it cool. The probe can be bent to any desired angle, and ulcerated surfaces cauterized. Several useful but expensive porte-caustiques have been invented for this purpose.

In these applications to particular spots, good illumination

must be had with the head-mirror, and the throat-mirror when necessary, and a speculum may be needed to dilate the anterior nares. It is difficult to make limited applications in the posterior nares and naso-pharynx, because the palate muscles contract easily, push back the mirror, and, grasping the instrument, the mucous membrane gets well cauterized when it is withdrawn. To obviate this, pass a loop of silk around the uvula, draw it forward, fasten the silk between the patient's front teeth, and have the patient breathe entirely through the nose. If this cannot be endured, or is not successful in keeping the palate away from the pharynx, and one cannot guide a sheathed caustic holder to the spot upon the index finger, the cotton wisp or sponge in the holder

FIG. 97.



GRANGER'S SPONGE-HOLDER.

must be used with mild cauterizing solutions. I have been obliged to depend upon the sponge-holder oftener than desirable.

For the sake of precaution, after applying a very strong solution or the solid caustic, and waiting a few minutes, the patient should gargle the throat and douche the nose with the usual salt solution, in order to neutralize any excess of silver nitrate that is likely to flow down the pharynx and do injury in its course. Spraying or syringing with the same will suffice, if the other measures are inoperative.

Certain powders are sometimes beneficial in ozæna, but I have had too little experience with them to warrant giving an opinion. Bismuth subnitrate, Boracic acid, Cubebs powder, Iodoform, and Magnesium carb. may be snuffed or blown into the nose after cleansing it. Two very convenient powder blowers are figured. They are useful in this connection, and for applying powders to a suppurating tympanum.

A recent writer claims to have cured several cases of ozæna in

two weeks, with snuff composed of Iodoform two parts and Acacia powder ten parts, applied three to six times a day. Others praise Iodoform, Mercury, etc., combined with vaseline or cold cream. Dr. Woakes recommends the use of various kinds of medicated cotton, packed in the nasal fossæ.

Hemorrhage of a mild degree is frequent in nasal catarrh, and can be arrested generally by the salt water or one of the astrin-

FIG. 98.



TIEMANN'S POWDER-BLOWER.

gent solutions. Sometimes the bleeding persists in spite of these, and other remedies must be tried. The patient should be assured there is no danger, and be kept quiet and calm, sitting erect in an armchair. If fainting occurs, the chair and patient can easily be inclined backwards awhile. When the usual domestic methods

FIG. 99.

SEXTON'S POWDER-BLOWER.

for arresting nosebleed have not been tried, if the flow is not excessive, they may be tested. Hold the right arm up perpendicular, put a piece of coarse paper under the tongue, dash cold water in the face, and snuff it up the nose, put a wet compress or a piece of ice wrapped in a towel upon the nape of the neck, and hold ice in the mouth. These failing, press the sides of the nose firmly together, and apply pressure over the facial arteries upon the superior maxillaries, just outside the alæ of the nose.

Should these proceedings fail, dilate the nostrils with a Frankel's speculum, and examine the illuminated fossæ for the source of

the hemorrhage. If this is visible in ruptured or ulcerated vessels, or fungous granulations, wipe the part clean and blow powdered tannin upon it, or apply a point of nitrate of silver.

I stopped immediately and permanently an obstinate, recurrent, and alarming hemorrhage from granulations, in a case of ozæna, by one application of lunar caustic to a fungoid excrescence.

If the source can only be approximately determined, stuff the affected side firmly by a probe and finger with non-absorbent cotton. An intelligent patient can materially assist in packing this into the crevices and crannies of the nose. Let the patient now incline the face a little forward and await results. If blood escapes by the side of the cotton or goes into the throat, remove the cotton, and douche and syringe the nose thoroughly with ice-water. Hot water may be tried instead of the cold in anæmic persons. If this does not succeed, substitute a cold saturated solution of tannin for the water, and wait. I have great faith in this; it does not stain nor excite inflammation, and I have succeeded in stopping dangerous epistaxis with it in two cases, after strong iron solutions had failed. I deprecate the use of iron solutions; they stain everything with which they come in contact, and cause inflammation and much distress to the patient. Monsel's solution (*Liq. Ferri subsulphatis*) is usually employed in this country, and may be sprayed, syringed or douched into the nose in various dilutions. One teaspoonful to an ounce of water should be tried at first, and then if necessary the strength may be increased until equal parts are used. Tincture of iron (*Tr. Ferri chloridi*) and water, equal parts, is highly praised, and has the advantage of being easily procured.

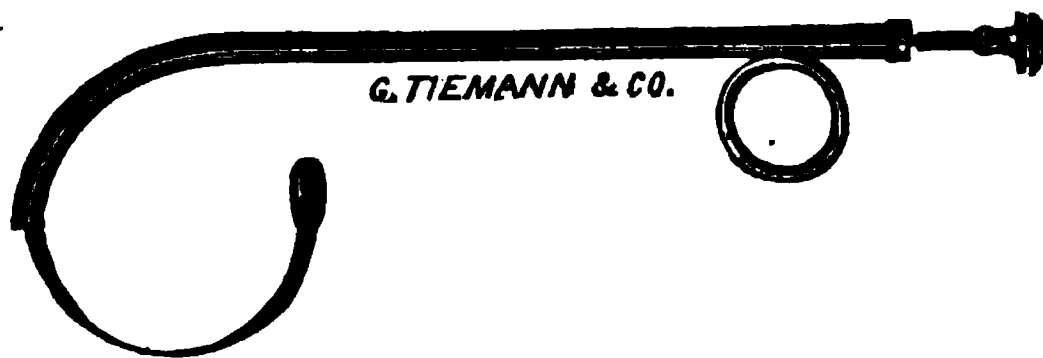
A pledget of lint wet with spirits of turpentine and introduced into the nose has arrested epistaxis after many other methods have failed. Rolls of cotton or linen, moistened with water, rolled in tannin, and packed into the nose, have been very effectual in some cases.

During this active local treatment, there may be opportunity and necessity for internal medication. Vascular excitement and tendency of blood to the head require Aconite, Belladonna or Veratrum viride. Depressed circulation and debility demand

Ammonium carb., Camphora, Cinchona, Digitalis, Ferrum, Nuxvomica, and Phosphorus.

In rare instances, the hemorrhage will continue in spite of everything mentioned, and the anterior and posterior nares must be plugged. Make two cotton roller bandages an inch long and three-quarters of an inch in diameter, and tie a strong string around the middle of each. Make two smaller rollers, but large enough to close the anterior nares. Introduce Bellocq's canula through the one side of the nose to the pharynx, push in the piston, and the knobbed spring will appear curving forward in the mouth.

FIG. 100.



BELLOCQ'S CANULA.

Secure the string of one roller to the hole in the knob, draw in the spring, withdraw the canula and thread. Proceed in the same manner with the other side of the nose. There will now be a string from each nostril, with the other ends to which the rolls are attached hanging out of the mouth. Now pull upon the strings from the nose, and draw the rolls into the throat, and then firmly into the posterior nares. Guide them in the throat with the index finger, so the length will be vertical. To the strings from the nostrils fasten the small rolls, so as to make each nasal fossa a closed cavity.

It may be necessary to plug only one side, if the bleeding is confined to it. In cases of doubt, or when the septum is perforated, both must be closed up. Remove the plugs in from one to three days, wash out the clots and secretions, and apply carbolized water for a day or two to correct fetor and decomposition, then go on with the usual treatment of the case.

Internal medication in chronic nasal catarrh is an important part of the treatment, and should be persistently kept up as long as the disease exists. It may be sufficient to effect a cure in mild

and recent cases without the aid of local treatment, but in severe and long-standing ones, it will not succeed alone, and the physician should not delay to institute the local treatment described.

The selection of the medicine is made from a careful consideration of the constitutional and local symptoms. A great many remedies are recommended for the treatment of chronic catarrh, which are practically useless and consumers of valuable time. Half the agents of the materia medica may be necessary to treat disorders that arise in the system of a patient with nasal catarrh; but the same necessity obtains in other patients without catarrh, and the medicines should not therefore be classed under catarrhal remedies.

A large majority of the patients are strumous, a few are syphilitic, and the balance rheumatic or gouty. These diathetic conditions furnish bold indications for certain groups of medicines, and from each group may be selected the one especially adapted to the local symptoms.

The following list embraces most of the medicines, whose reliable pathogeneses and clinical histories show them to be valuable in this disease: *Arsenicum iod.*, *Aurum mur.*, *Calcareo phos.*, *Ferrum iod.*, *Hepar sulph. calc.*, *Iodinium*, *Kali bichrom.*, *Kali hydriod.*, *Mercurius*, *Acid. Nitricum*, *Pulsatilla*, *Sanguinaria*, *Silicea*, and *Sulphur*.

Arsenicum iod. I prefer to any other preparation of the metal for strumous patients, with pale mucous membranes, and scaly eruptions upon the face or head. The discharge from the nose is rather watery and irritating; the upper lip and nostrils are reddened and excoriated; the Schneiderian membrane is relaxed, oedematous, granular, insensitive and, perhaps, ulcerated. The pharynx usually shows the granular or hypertrophic changes; there is burning rawness and slight soreness in the throat; the tonsils are enlarged; hawking to clear the throat is frequent; tinnitus and pain in the ear not infrequent. The face has a muddy color; the patient is weak and easily exhausted; fugitive pains in the chest, soreness at the root of the lungs, and occasional hoarseness show a tendency to tubercular deposition. I have seen these symptoms ameliorated in a wonderful manner by steady administration of this medicine.

Hepar sulph. calc. suits cases of less active symptoms, in much the same constitutions. When indicated, the naso-pharyngeal membrane feels raw and rough, and smarts sharply during inspiration of wintry air; the discharge is muco-purulent, sometimes bloody, and not very copious; the sense of smell is frequently very acute; the nose becomes stopped by swelling and crusts of bad odor; the eyes are irritable; there is pain and tension in the frontal sinuses; the nasal bones are sore to the touch; the upper lip is excoriated and swollen; the nostrils and inside of the nose are often covered with many layers of scab, which make the parts rigid and the passages impervious; the tonsils and submaxillary glands are indurated by chronic hyperplasia; the Eustachian tubes are affected, as the ears feel full and there is rattling on blowing the nose; ravenous hunger alternates with indifferent appetite, and the patient presents a picture of malnutrition and feebleness.

Kali bichrom. is demanded, when there is frontal headache, pain across the bridge of the nose, pressure and soreness of the nasal bones; sore nostrils, diminished power of smell, irritability of the eyes; thick, tenacious, mucous discharge, with occasional crusts and blood; considerable dryness and great soreness of the naso-pharyngeal mucous membrane, with chiselled-out ulcers here and there; ulcers covered by scabs upon the septum, with perforation or widespread destruction of the cartilage; swelling of the lymphatic glands; mucous rattling in the Eustachian tubes, and tinnitus; roughness of the throat with hoarseness. The remedy is lauded for its antisyphilitic virtues, but *Kali hydriod.* is probably more efficacious. The potash salts must be used sparingly in anæmia, as they are very destructive to the blood plasma.

Aurum mur. is used in graver states of ulceration of the mucous membrane and cartilage, and in caries of the nasal bones from syphilis. The discharge is greenish-yellow or yellow, containing dark particles; foul strings, crusts, and scabs are removed from the anterior and posterior nares; respiration is often impeded; the sense of smell is hypersensitive or lost; the nose is swollen both inside and out; the bones are very sensitive to pressure; disease of the lachrymal apparatus occurs from obstruction

of the downward flow of tears; the ears are affected by chronic catarrh or purulent disease; and the patient is apprehensive and morose. Why should gold cure disease? Nothing in its physical properties would lead us to suppose it would. So we might say of mercury, zinc, and copper, yet, experience has proved the value of all four metals in disease.

Mercurius may be necessary in grave destruction of the nasal mucous membrane, cartilage and bones. It suits milder cases, besides, when the mucous membrane is pale, gray, flabby, ulcerated and bleeds easily, and the nostrils are scurfy and sore; the nasal bones are tender, the Eustachian tubes filled with mucus; the throat slimy, and the mucous discharge grayish, fetid, and metallic.

Acid. Nitricum.—It was an old joke, that the professor at the University of Pennsylvania related annually to the class about the elimination of nitric acid. He said a country doctor gave nitric acid to his patient so strong, that when he blew his nose the mucus burned holes in his handkerchief. That's a peg for truth to hang upon. Nitric acid is required, when there is copious acrid, bloody discharge from the nose; the mucous membrane is raw, granular and ulcerated; thick mucus streaked with blood is blown from the nose or hawked out of the throat; false, easily exfoliating membranes form in the throat and nose; the bones of the nose and face are sore; the ears are in a condition of chronic catarrh, and there is deafness and occasional otalgia.

There may be destructive ulceration of the cartilages and bones of the nose from syphilis; and the patient may be suffering from the mercurio-syphilitic cachexia, and be weak, peevish and depressed. In such cases, nitric acid, by furnishing oxygen to the system, stimulates the morbid tissues to healthier action, tones up the general system, and aids in eliminating both the syphilitic and the metallic poisons.

Kali hydriod. is not used half enough in nasal catarrh. In good constitutions, having a rheumatic or gouty diathesis, it is required for nasal catarrh, with alternations of acrid watery discharge, and of thick yellow mucus. The mucous membrane of the throat is usually in the hypertrophic or granular stage; that of the nose is deep red, glistening and oedematous; nasal respira-

tion is alternately obstructed and free ; the Eustachian tubes and ears are somewhat affected ; the patient is fond of the table, and, if a man, smokes and, perhaps, drinks liquors.

A man I was treating for Bright's disease, received *Kali hydriod.* for some weeks, and was cured of a chronic nasal catarrh, and obstruction of the right side of the nose, which he assured me he had had for twenty-two years. The man's character was such as to render his evidence perfectly reliable. The remedy may be used sparingly in struma with swollen glands, and will be found very efficacious in all syphilitic cases. Iodine is suitable to the strumous and syphilitic patients, but not to the rheumatic or gouty.

Pulsatilla has been mentioned, as suited to mild cases of chronic catarrh. It is especially adapted to leuco-phlegmatic patients, with pale, atonic, and ulcerated mucous membrane ; a bland yellowish-green mucous discharge of offensive cheesy odor ; fulness at the root of the nose ; rawness of the throat ; fulness of the ears, and occasional tinnitus with headache. In women, the nasal catarrh is better during menstruation, and the discharge almost ceases, only to be greatly increased during the interval. When the discharge is profuse, the patient feels hungry all the time, and will want something to eat a few minutes after finishing a hearty dinner. Such cases are greatly benefited by this medicine.

Calcareo phos. is probably the most useful remedy for strumous cases. It combines the nourishing and alterative properties of lime, and the nutritive and stimulating properties of phosphorus, and may be employed where the symptoms correspond with those of *Calcareo carb.* and *Phosphorus*. In many cases of disease, where *Calcareo carb.* seems appropriate, and, yet, there exists a great deal of anæmia and nervous irritability, the phosphate will do much better than the carbonate.

The symptoms calling for its administration are : malnutrition of the osseous tissues ; imperfect digestion ; frontal headache ; pressure at the root of the nose ; supra-orbital pain on one or both sides ; a mild mucous discharge, mixed with crusts and, occasionally, with blood ; roughness of the throat ; downward passage of scabs in the pharynx ; more or less obstruction of the

Eustachian tubes, with tinnitus and deafness. The nasal membrane is pale, fungous, flabby and ulcerated; the throat shows the atrophic pharyngitis; the palate is frequently relaxed, and the ears full and ringing.

Ferrum iod. is a medicine applicable to the same class of cases as *Calcareo phos.*, but more particularly indicated, when the anæmia is profound, and the powers of digestion and assimilation are much weakened. There is not a shadow of a doubt about iron enriching the blood, when administered in small doses.

When the system will not abstract iron from food, it will receive and retain it from minute doses, because of some mysterious tonic influence the metal seems to exert upon the stomach and absorbent system. The iodine in this preparation exercises its usual alterative influence upon morbid tissues and glandular infiltration, so that the remedy is suited to chronic nasal catarrh in strumous persons.

It should be administered when there is anæmia, weakness, glandular enlargement, roughness of the throat, hoarseness, raw sore feeling in the nose, continuous thin mucous discharge from the nose and throat, relaxation and ulceration of the Schneiderian mucous membrane, and the variable symptoms of the nasal disease.

Sanguinaria has a limited range of action in this disease, but is better for the acute stage. It is said to promote the absorption of polypus, but the evidence of this power is not voluminous.

Sulphur may be needed as an intercurrent remedy, but cannot be regarded as having any specific action upon the disease or the constitutional state which accompanies it.

Silicea has an imposing pathogenesis, but it is difficult to say how much is reliable. The symptoms calling for silicea are: headache, bruised pain over the eyes, irritation and inflammation of the eyes; sneezing, with dryness of the nasal mucous membrane or an acrid corroding discharge; occasional bleeding of the nose; pricking and soreness of the throat; tinnitus, fulness, and pain in the ears; hoarseness, and dry hacking cough. I cannot recommend silicea enthusiastically, as it has disappointed me frequently. I think some of the other medicines mentioned above will prove more satisfactory.

Treatment of Polypus.—These tumors never exist in the nose or pharynx without some degree of catarrh, and, indeed, are generally preceded by it, so that the proper medicine for the catarrh will be the most appropriate for the removal of the polypus. Calcareo carb., Kali bichrom., Pulsatilla, Phosphorus, Sanguinaria, Sulphur, and Teucrium are considered powerful remedies for removing the excrescences.

That internal medicinal treatment has cured polypi seems to be well established, and in all cases one may treat the patient internally, while carrying on the local treatment indicated. When means for the speedy cure of polypus are at hand, I think it would be improper, to say the least, to postpone their use until a long course of internal medication has been tried.

In addition to the cleansing and medicated fluids employed for the condition accompanying polypoid tumors, I would advise the application of strong solutions, and, even, crude substances directly to the morbid growth, whenever it can be seen or felt.

The fluid applications should be made with a brush or a small piece of sponge in a holder. The handle should be flexible, so it can be bent to reach the growth through the nostril or up behind the palate as desired. In the latter case, it will be necessary to use the throat-mirror to direct the instrument, or to employ the finger as a guide for a special instrument.

I have devised one, which I call the Guarded Sponge-holder; it terminates in a tiny cup, holding a small sponge attached to a disk, that can be projected and retracted at pleasure by a piston working in the hollow stem.

The cup limits the application to the part touched by the sponge; the sponge is pulled back into the cup after its fluid is squeezed out by the piston, and the whole is withdrawn without medicating any other than the part intended.

Acetic acid (*Acid. Aceticum*), Tincture of iron (*Tr. Ferri chlor.*), solution of Subsulphate of iron (*Liq. Ferri subsulph.*), solution of Zinc sulphate (*Zinci sulph.* ʒj, *Aqua dest.* fʒj), and solution of Nitrate of silver (*Argent. nit.* gr. xl, *Aqua dest.* fʒj) are the fluids I employ for polypus and the peculiar adenoid tumors of the naso-pharynx.

One must be careful not to take up too much fluid upon the

instrument, and then drop it upon other parts than those desired. It is sufficient to apply one of these to the tumor, twice or three times a week, and the other local measures should be carried on as usual.

The hypodermic syringe may be employed to inject one of the above remedies, preferably the Acetic acid, when the tumor is easily reached; there is risk of causing embolism if the tumor is very vascular, and the method is not recommended in such cases.

Dr. C. R. Upson, of Atlanta, Ga., has invented a very useful syringe for injecting and destroying tumors in the naso-pharynx and larynx.

“It consists of an ordinary hypodermic syringe, provided with a long hollow needle, which is passed through a silver canula properly curved at its extremity. The outer surface of the needle,

FIG. 101.



UPSON'S TUMOR SYRINGE.

a short distance from its attachment to the syringe, has cut upon its surface a screw-thread, which is fitted with a traverse nut, to regulate the depth of puncture of the growth. Two shanks, with finger-rests at one end, are passed through rings on the side of the syringe, and attached at their other extremity by means of set-screws to the canula, to enable the surgeon to operate the instrument with one hand. The flat wings at the end of the syringe serve as thumb-rests. The tip of the canula is made to unscrew, and in its place can be fitted the fine spray-jet which accompanies the instrument. With this jet, applications of any desired medicament can be made either to the pharynx or larynx.

“The modus operandi of the instrument is briefly described. First charge the syringe with the desired quantity of the solution to be injected—say Acetic acid, gtt. x-xv; then place the patient in a good light—either direct or reflected—draw forward and

depress the tongue with a proper instrument, which may be intrusted to the patient to hold, or the tip of the tongue may be covered with a napkin, drawn forward, and held out of the way by the patient. After cautioning the patient to breathe quietly through the nose, introduce the rhinoscopic mirror below and a little back of the palate, and, as soon as you secure a good image of the growth in the mirror, introduce the canula with the free hand, project the needle the desired depth into the growth, move the thumb back from its rest to the piston, and slowly inject the contents of the syringe into the tumor."

Tannin, Alumen exsiccatum, Cubebs, Sanguinaria, and Teucrium are often used in powder, and snuffed in the nose or blown upon the excrescence. The latter is much the better method of procedure, as the substance can, thus be in a measure limited to the growth. A powder-blower is the best to use for this purpose.

Ascertain first that the tumor can be reached, then take a little of the powder in the tube, place its distal end against the tumor, and blow the powder out. It does not matter whether you do

FIG. 102.



NASAL POLYPUS CANULA.

this by connecting a rubber tube or an air-bag with the blower, though the latter is more agreeable. After such an application, it is best to suspend other local treatment for a day or two and watch its effect.

When the tumor is quite large, and local measures and internal medication have been fairly tried without success, surgical treatment must be essayed.

The problem is to remove mechanically a tumor from the nasal fossa or upper pharynx. The usual methods are by ligature and by forceps. Whenever the polypus is within reach, and of such a shape that a ligature can be thrown around it, I prefer the cord or wire to the forceps.

In applying a ligature, a great deal of patience and manoeuvring is often necessary. In some cases, the wire loop of the Wilde-

Blake snare or of the nasal polypus canula can be slipped over the growth and the thing cut off in a trice.

In others, a silk or wire ligature must be passed around the tumor by the aid of probe, forceps, aneurism needle or Bellocq's canula. One must look, and work, and poke carefully, in order to be successful.

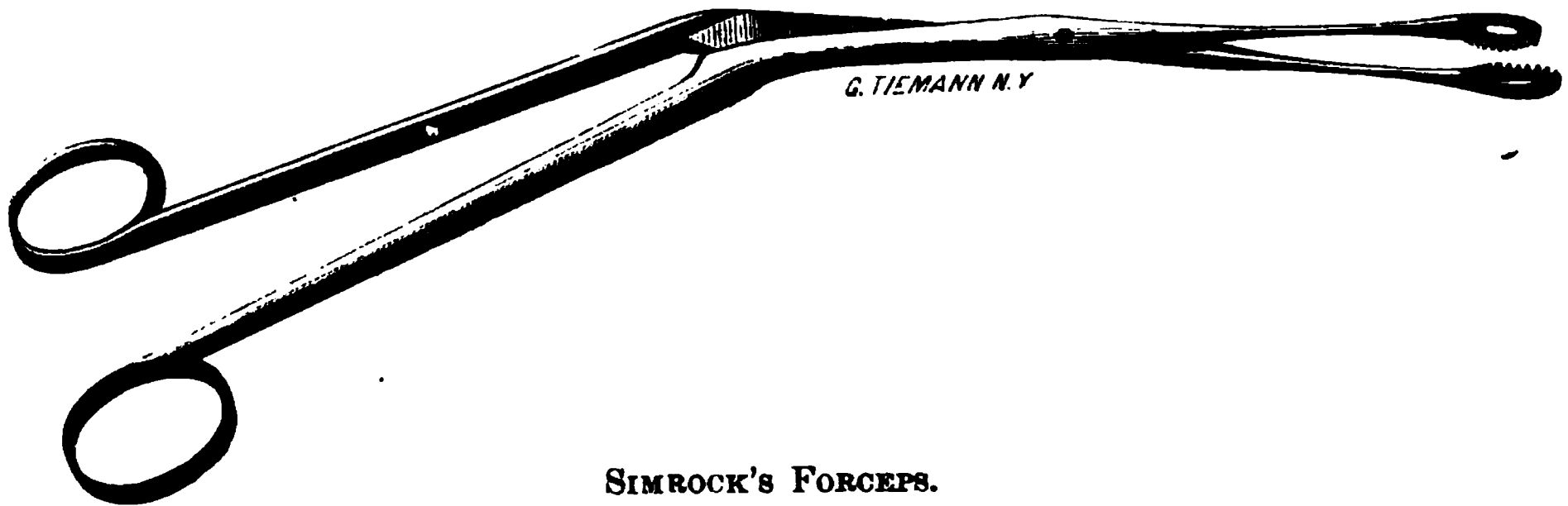
When the ligature is once around, it should be pushed near the pedicle, drawn tight, and twisted and pulled until the growth comes away. It is not agreeable to tie and leave it in position until sloughing occurs. Hemorrhage is usually slight, and easily controlled by cold water or an astringent.

Some years ago, I had a large pyriform polypus to remove from the posterior nares. The growth sprang from the sphenoidal region, and hung down into the naso-pharynx. I failed to pass a loop around it, and nipped it with forceps so that it bled profusely. I did not like that nor the prospect of abundant hemorrhage in the region, so I worked away with a ligature. Finally I passed Bellocq's instrument upon the outer side of the tumor, and drew a string through the nose; then having reintroduced the instrument, I succeeded by turning the beak of the canula around the vomer in getting another cord through the same meatus inside the morbid growth. I knotted the two cords from the mouth together, drew the loop backward and upward by pulling upon the other ends, and slipped it over the tumor. Then I twisted the cords together hard, pulled moderately, and had the satisfaction of drawing a rather firm mucous polypus out of the nose.

Many surgeons prefer to use the forceps for the removal of cysts and polypi, and this is the speediest and most brilliant method of operating. The patient should be seated in a good direct or reflected light with the head thrown a little back against a firm support. In operating through the throat, a slip-noose should be put around the uvula, the soft palate drawn forward by it, the string fastened between the front teeth, and a cork placed between the jaws to keep them open. Removal of a piece of the inferior turbinated bone and a projecting side of the septum has been advised. The patient should be required during the operation to breathe through the nose if possible. This will give

more room to work. The throat-mirror and index finger are used to guide the forceps when operating behind the palate. •

FIG. 103.



SIMROCK'S FORCEPS.

The location of the tumor having been ascertained, a pair of properly shaped forceps should be introduced into the nasal meatus,

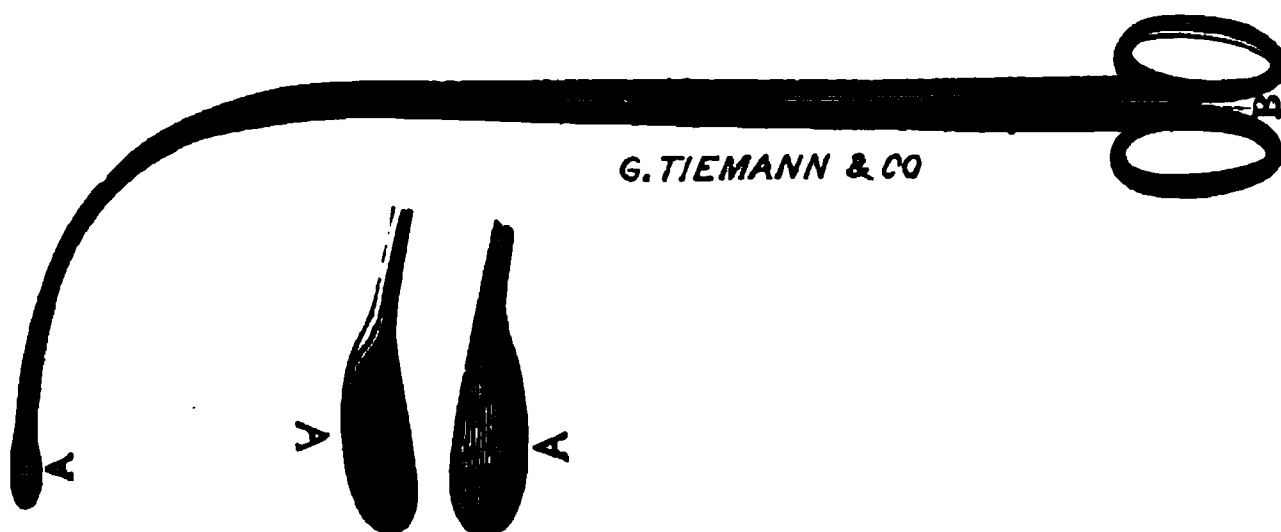
FIG. 104.



TIEMANN'S FLEXIBLE THROAT FORCEPS.

the nostril of which is dilated by a speculum, or else up behind the palate; the growth should be seized firmly, twisted as much as possible with the instrument, torn off, and removed.

FIG. 105.



FAUVEL'S FORCEPS.

Various shaped instruments are necessary to meet the requirements of all cases, but the most generally useful is Simrock's forceps.

These are angular at the junction of the blades and handles, and have fenestrated, serrated blades.

Fauvel's polypus forceps are strongly curved and adapted to both naso-pharynx and larynx.

FIG. 106.



NOYES'S POLYPUS FORCEPS.

After the tumor has been removed as thoroughly as possible, control the bleeding by gargling, syringing, and douching with cold water or astringents when necessary, and continue the treatment proper for the diseased mucous membrane.

For the surgical treatment of severe or complicated cases, the reader must refer to works upon general surgery. Dr. Helmuth has a full exposition of the subject in his *System of Surgery*, and gives an excellent résumé of an operation for resection of the nose for the removal of polypus.

Treatment of Adenoid Tumors.—These growths in the naso-pharynx are treated much the same as polypi, for which they are generally mistaken. Having made out the size, shape, color, consistency, position, and attachment of the morbid growths by palpation and inspection with the mirror, the condition of the mucous membrane of the choanæ should be observed, and the treatment determined. The medicines used for polypus, and some of those under chronic nasal catarrh should be studied, and those indicated tried awhile. They will probably prove useless, and local treatment must be adopted to effect a cure.

When the tumors are flat, sessile, rather smooth, and numerous, they must be treated by astringents and escharotics, as attempts to remove them by instruments would injure the mucous membrane and cause unfortunate cicatrices.

The nasal douche, post-nasal syringe, and atomizer, with the solutions of salt, muriate of ammonium or chlorate of potassium should be used daily to cleanse the parts from the morbid discharge generally present; then a solution of Zinc sulphate gr.

xxx, of Silver nitrate gr. xx, or a dilution of tincture of Chloride of iron, fʒj, to fʒj of water, should be sprayed into the pharyngeal vault upon the tumors every day, and a gargle of an even teaspoonful of salt to a pint of water used soon afterwards.

Twice a week the morbid growths should be touched with a brush or the sponge in its holder, wet with Silver nitrate gr. xl in distilled water fʒj, or with the pure tincture of Chloride of iron, and after waiting five minutes for the remedy to act, a salt-water gargling and syringing or douching must be had to limit extension of the active agent employed.

If these measures with hygienic regulations and internal medicines do not make the adenoid hypertrophy diminish, and give signs of disappearing in a few weeks, it would be proper to apply pure lunar caustic to the outgrowths.

A silver probe bent to the desired degree should be dipped in fused pure nitrate of silver and cooled. Then the uvula should be drawn forward and fastened, the patient instructed to breathe through the nose, the tongue held down, the throat-mirror warmed and introduced, the probe carried into proper position as seen in the illuminated mirror, and its caustic rubbed briskly upon the tumors. It is important to use a gargle and douche of salt water five minutes after this application, as the caustic dissolves in the mucous discharge about it, and, unless neutralized, will run down the pharynx and excite inflammation in it, the œsophagus, and, perhaps, the larynx. In the intervals between the caustic applications, the same cleansing and astringent treatment should be followed as described above.

When the tumors are nodular, pedunculated, pyriform or rough and jagged like the comb of the cock, and astringent and caustic treatment does not remove them, it will be necessary to resort to Upson's injecting, to ligation, crushing, and twisting off with forceps, or to ablation with cutting instruments.

Large tumors may be injected with acetic acid by Upson's syringe. The ligature and snare are seldom applicable, and their use requires no description beyond that given under the treatment of polypi. Forceps of proper shape guided by the finger or mirror may be passed through the nasal meatus or up behind the palate, and a tumor seized and twisted out of the pharynx.

geal vault, or crushed so that it will slough away; but the operation is difficult unless the excrescence is quite large and easily reached.

A cutting instrument is generally necessary. Lœwenberg recommends a suitably curved curette, with which the tumors can frequently be scraped away. The use, however, is difficult, and he prefers a cutting forceps of his own invention. I translate his description of the instrument and his method of using it.

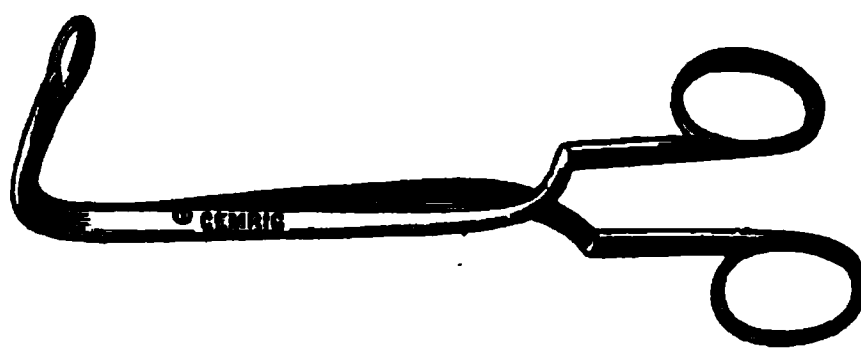
FIG. 107.



LŒWENBERG'S CURVED CUTTING FORCEPS.

“It is a forceps terminated by two cutting blades of which the sharp edges are applied against each other when the instrument is closed. It possesses a double curvature in S. The joint

FIG. 108.



LŒWENBERG'S ANGULAR CUTTING FORCEPS.

is placed near the bite in order to preserve a great length of branches, which gives a powerful leverage and permits easy cutting. The beaks cut by closing. They are slightly rounded and excavated on their inner face.

“This is how we employ our instrument: Guided by the rhinoscopic mirror or by the left index finger, one introduces the forceps closed, then one opens them and cuts the vegetation the nearest possible to its base.

“A single cut is sufficient for a slender pedicle or the base of a sessile vegetation of small dimensions; the voluminous tumors demand naturally more cuts of the instrument. It is the same for

the true polypi, that one can operate upon equally well by means of our instrument." *

There is always more or less hemorrhage after instrumental removal of these tumors, and a cold water or astringent douche or injection must be employed. In severe cases, tannin or powdered alum may be blown upon the bleeding surface, or a large moist compress rolled in either might be held against the vault of the pharynx by a string passed through the nose.

When the adenoid tumors or polypi prevent respiration through the nose after the passages are cleared, the Eustachian tubes and middle ear must be opened, and the mucus driven out by repeated strong inflations with the air-bag. The same system of cleansing the pharynx and making topical applications suitable to the morbid conditions must be continued, according to principles already laid down.

Treatment of Enlarged Tonsils.—This is generally associated with that of chronic pharyngitis, but I think it better to keep the affections distinct.

Hypertrophy of the tonsil is easily cured in children, is said to disappear spontaneously with the advent of puberty, but is refractory in adults.

Glandular hypertrophy indicates debility, and every means ought to be used to improve the general health of the patient. The throat should be gargled every morning and evening with a solution of an even teaspoonful of common salt in a pint of water. If the patient is too small to gargle, the solution may be applied to the throat with an atomizer. When the tonsils are red, tender, and ulcerated, a solution of chlorate of potassium, gr. xvi in an ounce of water, will prove much more efficient than the salt, and may be sprayed upon the glands three or four times daily. Another topical application of decided value is tar tincture, f ʒj in an ounce of water, used in the same manner. A solution of nitrate of silver, gr. xx in an ounce of distilled water, applied to the tonsils by a brush or tuft of cotton on the holder,

* *Les Tumeurs Adénoïdes du Pharynx Nasal; Leur Influence Sur l'Audition, la Respiration et la Phonation, Leur Traitement.* Par Le Dr. B. Löwenberg; V. Adrien Delahaye et Cie. Libraires-Editeurs, Place de l'École de Médecine, Paris, 1879.

every other day for many weeks, will cause a diminution in size. The tongue should be held down for a few minutes, and then a salt solution applied to neutralize and limit the action of the remedy. Equal parts of glycerine and tincture of iodine or of glycerine and tincture of the chloride of iron, applied in the same manner, are as efficient and rather more agreeable to the patient and physician than the silver solution. A short time after the application the mouth should be rinsed with water.

A recent writer asserts, that enlarged tonsils may be caused to undergo shrinking by applying to them every day or two crude bicarbonate of sodium.

Another method of inducing retrograde metamorphosis is to inject iodine into the gland. This is the most effectual way of shrinking an enlarged tonsil, and may be tried before resorting to ablation. Mix five parts of tincture of iodine with fifteen of alcohol, draw three or four drops into a hypodermic or the Upson syringe, push the syringe needle half an inch into the tonsil, then withdraw one-fourth of an inch, and inject the contents into the tissue. Three or four injections in a month will be sufficient, and improvement may be confidently expected except in the oldest and worst cases.

The administration of medicines should commence with the gargling and spraying, and the silver or iodine ought not to be resorted to until the internal remedies have had a fair chance to cure, and have failed. Two or three months treatment will show whether the tonsillar disease is yielding to the secret and insidious action of the internal agent.

Sulphur is recommended for recent hypertrophy, when the tonsil is swollen by the remains of inflammatory exudation, rather than by hypertrophy of the proper tissue elements.

Mercurius is more valuable than Sulphur in this same condition, especially, in young subjects, and should be given for a time in the early treatment of all but the old cases.

Baryta carb. is highly praised by authors, for patients with a tendency to acute exacerbations of tonsillitis, considerable hardness of the gland, and paresis of the throat muscles. I believe its virtues are very much overestimated.

Calcareo phos. has a decidedly beneficial action upon enlarged tonsils, as upon swollen glands elsewhere. It is indicated when

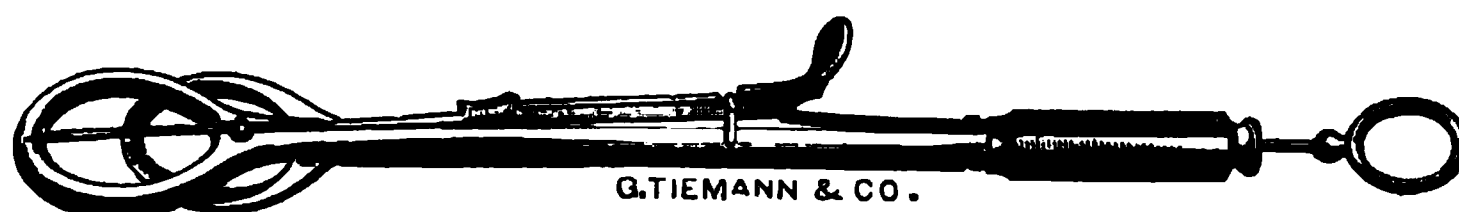
the gland is large, pale, flabby and, perhaps, ulcerated in places. In all strumous cases in young persons, a course of Phosphate of lime diminishes glandular hypertrophy and improves the general health in a surprising manner.

Calcareo iod. is a valuable medicine for hypertrophied tonsils, when they form red, nodular tumors of considerable hardness, and there is much catarrh of the throat, with frequent attacks of hoarseness.

When local measures and internal medication have had a fair trial, and have failed to diminish tonsillar hypertrophy to a size consistent with comfort and health; when one or both of the tonsils is quite large, very firm, and a serious obstacle to the physiological action of the throat, then a surgical operation is demanded.

It is not necessary to remove the whole tonsil. Experience has proved, that if a liberal slice be taken from the gland, the remainder will shrivel and shrink to a moderate size. The patient should be seated erect in a good light, the mouth held wide open by a cork between the molar teeth of one side, and the tongue held down by a depressor. Then pass Fahnestock's tonsillotome back to the tonsil; carry its ring over the gland until as much is through as it is considered desirable to cut off; push the sharp retainer through the tonsil; draw the circular knife outwards, and remove the instrument. The piece removed will be spitted upon the retainer. The pain from the procedure is very little, and children bear it very well.

FIG. 109.



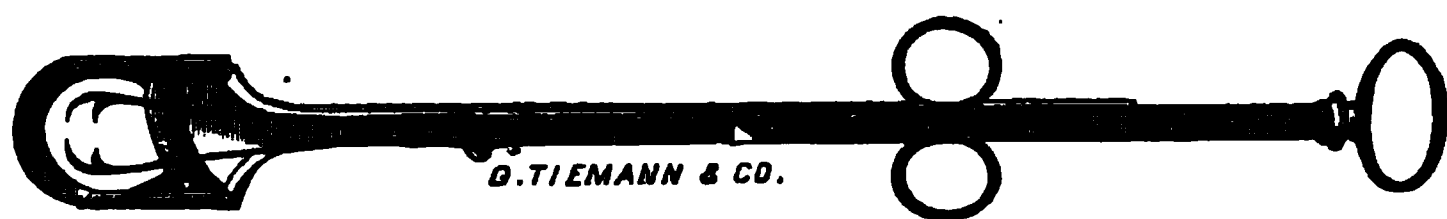
FAHNESTOCK'S TONSILLOTOME.

There are two movements connected with the instrumental manipulation, pushing in the retaining needle, and drawing back the annular knife. To simplify the manoeuvre, Billing's tonsillotome was invented. It consists of a pair of rake-tooth forceps, placed over the oval opening for the amygdala. A chisel-like

knife slides lengthwise of the oval, between the claws and the body of the instrument.

The first two fingers are passed into side rings upon the body, and the thumb into the ring upon the proximal end. The instrument is applied with the claws inwards; enough tonsil is worked through the oval; the instrument is held steadily, and the thumb pushes the chisel blade backwards and home. This movement causes the claws to grasp the tonsil, and drag it through somewhat, so that the chisel knife cuts it off with a slope outward and backward, corresponding with the natural outline of the throat in this part. Thus one movement secures and removes the piece of tonsil, and fashions the remainder; the instrument is, therefore, preferable to Fahnstock's.

FIG. 110.



BILLING'S TONSILLOTOME.

The hemorrhage from the operation is generally slight and easily arrested by a gargle of cold water; or, in case of necessity, by a solution of tannin. When it continues notwithstanding these, a tuft of absorbent cotton or a camel-hair brush should be dipped in iron tincture or a xx gr. solution of nitrate of silver, and the cut surface painted freely.

Dr. Seiler says, "I am in the habit of always painting the cut surface with nitrate of silver solution, since it seems to start the process of repair at once, and at the same time protects the wound from the influence of the air."*

In very rare cases, it may be necessary to make pressure upon the cut surface with the finger, or, even, to twist the open end of a rigid vessel to arrest obstinate hemorrhage.

There is no danger in removing a piece of the tonsil, if the instruments are used according to directions. The carotid artery ascends just outside the tonsil, and a very deep cut or an attempt to operate with a tenaculum and bistoury might be dangerous.

* Hand-Book of Diagnosis and Treatment of Diseases of the Throat and Nasal Cavities. By Carl Seiler, M.D., etc. H. C. Lea & Co., Philadelphia, 1879, p. 116.

The wound glazes over soon and heals generally within a week, during which time the patient should take fluid and soft food, and abstain from irritants. Medicines may be given according to any special indications present.

Treatment of Chronic Pharyngitis.—This must be general for all varieties, including every hygienic measure for improving the health of the patient; and special, including local and internal remedies for the three phases of the disease which I have presented. The disease may be cured; but, failing in curing, it may be so greatly diminished, that no discomfort or injury will be experienced through life. Nearly every one in the temperate zone has some pharyngitis. Until it reaches a certain grade it does little harm. It must be kept within narrow limits.

The subject of chronic pharyngitis ought to live in a dry climate, preferably upon high ground, in a well-ventilated and properly heated dwelling. He should keep the skin active by frequent baths; bathe the neck every morning and evening in cold water, and rub dry with a crash towel; wear merino underclothes in summer, and flannel in winter; avoid drafts and needless exposure to bad weather, and take proper exercise in the open air daily.

Respiration should be through the nose when possible; the mouth ought to be kept closed the most of the time, especially, in foul, dusty or cold air; the swallowing of very hot and very cold things at the same meal must be forbidden; good plain food only should be permitted; spices, strong liquors and tobacco are very irritating to the throat and should be avoided; and using the voice in either singing or speaking reduced to a minimum. It is beneficial for every person afflicted with pharyngitis to gargle thoroughly every time he takes a drink of water. This removes superfluous mucus, cools and stimulates the mucous membrane, and improves the state of the throat and Eustachian tubes by the muscular action that ensues.

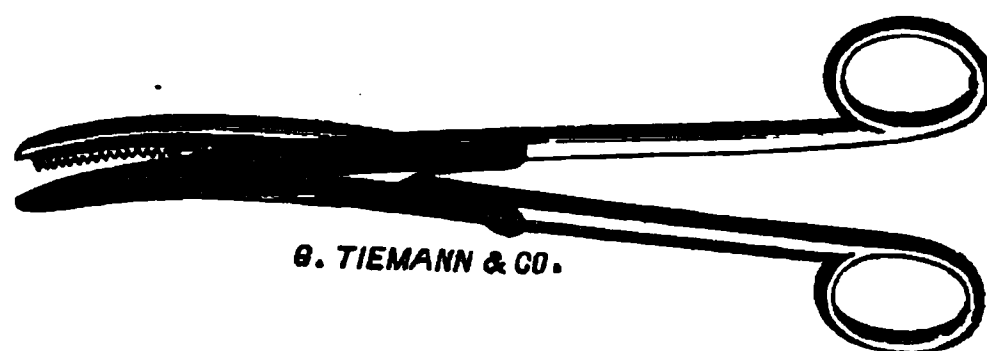
The Eustachian tubes and middle ears ought to be inflated by the air-bag or Valsalvian method, as often as the symptoms of fulness, râles, and tinnitus indicate obstruction to the entrance of air. The frequency of the demand will vary from once or twice

a day, to once or twice a week, according to the extent and severity of the disease.

Treatment of Hypertrophic Pharyngitis includes other gargles besides cold water. An even teaspoonful of salt to a pint of water is one of the best. It should be used as a gargle the first thing in the morning and the last thing at night, and continued many weeks, or until the pharyngitis is altered in character or cured. Chlorate of potassium in the same proportion is better than the salt, if there is much sensitiveness. The pharynx should be sprayed daily with tar-water (*Tr. Picis liq. f3j, Aqua f3j*), and the atomizing tube must be passed deeply into the throat, and through each nostril, in order to reach all parts of the vault.

If the condition of the mucous membrane does not improve in time under these topical applications and the internal medication, a solution of sulphate of zinc (*Zinci sulph. gr. x, Aqua dest. f3j*) should be substituted for the tar-water, and the treatment continued. This failing, nitrate of silver solution (*Argent. nit. gr. x, Aqua f3j*) should in turn replace the zinc, and care be taken

FIG. 111.



UVULA SCISSORS.

to limit the application to the diseased parts, and not to stain normal tissues or the clothes. It is well soon afterwards to have the throat gargled with salt water, in order to prevent the silver getting down the œsophagus and into the mouth.

If there is swelling about the Eustachian tubes, the silver solution may be applied with a throat-brush or sponge in holder, and a drop or two of this or some other agent can be injected through the catheter. Inflation with the air-bag should not be forgotten in case of obstruction to the entrance of air to the tympanum.

When the uvula is elongated so that it rests upon the base of

the tongue and causes frequent coughing and gagging, if it does not retract under the zinc or silver applications, it should be seized and its oedematous point cut off with the uvula scissors. The latter have the handles bent so the hand will not obstruct the sight, and beneath the blades, a rake-tooth forceps is attached which seizes the amputated piece.

Calcareo phos. is the best medicine for hypertrophic pharyngitis, in young persons of strumous or lymphatic constitutions, especially, when the tonsils are enlarged and the ear affected. Under its continuous administration, and daily spraying with the tar-water, I have seen the mucous lining of the throat become lighter and thinner, and the glands much diminished in volume.

Ferrum iod. is a most valuable agent for the same class of patients, when lymphatic glands harden a little, and anæmia and debility are noticeable. A few drops should be given in water after meals, in order to avoid any unpleasant stomach sensations.

Mercurius is very useful, when the gums and tongue are flabby and softened; the tongue is coated at the base; a thick sticky secretion clings in the throat; there are, perhaps, spots of ulceration; the tonsils are enlarged and submaxillary glands swollen; the appetite and digestion are impaired; the taste and breath are foul, and the patient is in bad health. It is frequently indicated in the early stages of a case, when there is tinnitus and tubal obstruction, but other medicines suit later stages better. I give usually the *Mercurius sol.* in powders or *Mercurius corros.* dissolved in water. *Merc. iod* is preferable, if there is suspicion of syphilis.

Kali hydriod. is a capital remedy for hypertrophic pharyngitis, in stout plethoric persons, who are *bons vivants* and do not curb their epicurean desires. Sometimes there is a persistent soreness of the throat, and moist mucous râles in the tubes and ears, connected with the congestion and hypertrophy, which is supposed to depend upon a rheumatic or gouty diathesis. There may be stiffness of some of the joints, and dull pain in the muscles. In such cases, the potash salt is very efficient in removing the general morbid symptoms, and curing the pharyngitis.

Nux vomica is indicated, when the appetite and digestion are poor; the throat is full and slimy; there is decided tinnitus and

occasional otalgia ; mucus clings to the posterior wall of the palate and pharynx, causing frequent hawking and gagging, and the patient may have been in the habit of using liquors or tobacco in excess.

Treatment of Atrophic Pharyngitis differs from the hypertrophic considerably. The usual salt gargle agrees very well with some patients, but is too irritating and drying for others. If the mucous membrane is humid and the secretion active, it will prove beneficial. When there is only a moderate secretion of mucus, and the mucous membrane is here and there dry and glazed, a glycerine gargle (*Glycerinum* f℥j, *Aqua* f℥ij) is far preferable, and barring a little smarting, is exceedingly pleasant to the patient. It is well for the physician to spray the pharynx with the same mixture for awhile, until it becomes evident other topical remedies are necessary. It may be employed until the mucous membrane takes on a different action and remains moist, and then the tar-water should be used in alternation with or instead of it. This agent stimulates and tones up the membrane, and cleans and favors the healing of ulcerations.

Another spray that is of decided benefit in some cases, is a solution of tannin in glycerine and water (*Acid. tannicum* gr. x, *Glycerinum* ℥ij, *Aqua* f℥vi).

Relaxed tissues, dilated vessels, œdema of the uvula, and spots of gray ulceration demand this remedy.

In cases with weakness and paresis of the throat muscles, when the tar seems to have exhausted its power, a cinchona spray (*Tr. Cinchonæ* f℥j, *Aqua* f℥j) is sometimes wonderfully efficient. It improves the condition of the mucous membrane, and being absorbed promotes the nutrition and force of the muscles.

It may be necessary to treat congested, granular or ulcerated portions of the pharynx to brushings of nitrate of silver. I do not recommend the use of this agent freely in atrophic pharyngitis. It is better to apply a twenty-grain solution by brush, cotton or sponge to the particular parts needing it, taking care not to let a useless surplus run upon other parts of different pathological nature. Thus coarse granulations, spongy congestions, and ulcerated places, which resist the gargling, spraying, and constitutional treatment, will often require mild cauterization

with silver nitrate. The salt safety gargle ought to be used a few minutes after applying the silver, and then the usual course of treatment continued until other measures are necessary. It may be advisable to amputate the uvula, and to inflate the middle ear often.

Arsenicum iod. is one of the most searching, deep-acting, and efficient remedies for this kind of pharyngitis. Arsenic is an alterative tonic, and iodine an alterative absorbent, and the elements combined retain their power little changed.

Calcareo iod. is a nutritive alterative of great value in this disease, especially in children with rachitis and other strumous disorders. Lime is an essential element in the tissues, and the assimilating power for it seems to be deficient in scrofulous patients, with atrophic and paretic conditions of the pharynx, accompanied often by chronic nasal catarrh. *Calcareo iod.* may be administered much longer than the *Arsenicum iod.*, and in the same or larger doses. It will take the place of the latter very well, when it is desirable to stop it for awhile.

Calcareo phos. is very well indicated in some of these strumous cases, especially, when the tonsils are hypertrophied and other glands enlarged.

Cinchona is good both as a local and internal remedy. It stimulates the mucous membrane to better action, and is an irritant to the muscles. It produces muscular trembling, due to its influence upon muscle fibre, and not to action upon the nerves, and is, therefore, an appropriate medicine for atrophic pharyngitis with weakness of the muscles, variable hearing, considerable tinnitus, and general debility.

Ferrum iod. is occasionally needed in the atrophic phase of pharyngitis, as in the hypertrophic. Pale, thin, anæmic, debilitated patients are much benefited in general health by its administration, and then the throat and glandular implications improve.

Kali bichrom. has an affinity for the mucous membranes, and is occasionally needed in atrophic pharyngitis, complicated or not by nasal catarrh. The symptoms calling for its administration are: A yellowish-red or tawny color of the pharynx; relaxation of the palate, and œdema of the uvula; shallow grayish ulceration, showing no disposition to heal; red, swollen or ulcerated

tonsils; dryness and soreness of the posterior surface of the soft palate; hawking of thick tenacious mucus, difficult to dislodge; and mucous râles in the Eustachian tube and ear.

Sulphur may be required as an intercurrent remedy, but should not be given long or relied upon to cure. It is indicated by the atrophic condition of the mucous membrane, and prominence of the follicular glands; deafness and tinnitus; rough, dry, sore throat; a slight secretion of mucus, and swelling of the submaxillary glands.

Treatment of Granular Pharyngitis consists in some of the measures and remedies employed in the other two varieties of pharyngitis. The salt gargle morning and evening is a necessity, and, at noon, a spray of tar-water, or of zinc sulphate or tannin in glycerine and water, as described above, should be applied freely to the throat and naso-pharynx. Should the treatment not improve the condition of the mucous membrane after a fair trial, a ten-grain solution of nitrate of silver should be applied with a brush to the entire diseased surface, once or twice a week, for a little while, the other treatment being continued. This will stimulate the mucous membrane to healthier action and aid the cure. The region of the Eustachian tubes should receive special attention, and, if it cannot be touched by the brush, a sponge in the holder may be used instead.

The internal medicines adapted to this kind of pharyngitis must be selected by a comparison of the symptoms of those already given. I have found *Arsenicum iod.*, *Mercurius*, *Kali hydriod.*, *Kali bichrom.*, and *Sulphur*, the most efficient against the morbid condition.

The hypertrophied follicles, large spongy granulations, and small polypi seen upon the wall of the pharynx on a level with and above the palatine arches must be destroyed by caustics or cautery. A probe coated with nitrate of silver may be pressed against the smaller growths and a salt gargle or spray used soon afterwards to neutralize excess. A cottoned probe wet with chloro-acetic acid may be applied in the same manner, and a gargle or spray of simple water used instead of the salt solution. Larger excrescences may be nipped off by cutting forceps. A preferable method is to apply a bullet-pointed electrode of a

galvano-cautery and burn the growths to their bases. A cold-water gargle may be used for a few days, and then the other treatment continued.

Treatment of Chronic Inflammation of the Eustachian Tube. It is taken for granted, that morbid states of the nose, pharynx, and throat will be treated according to directions already given. The mouths of the Eustachian tubes may require a little extra attention. Œdematous swelling of the lips must be sprayed or brushed daily with a ten-grain solution of tannic acid or zinc sulphate.

A granular spongy state of the mucous membrane will need brushing every few days with a ten or twenty grain solution of silver nitrate, and this is the best topical remedy for ulceration. Relaxation or paresis of the palato-tubal muscles, collapse of the parietes of the mouth of the tube, and atony of the parts demand the Cinchona (*Tr. Cinchonæ* f ʒj, *Aqua* f ʒj) or the tar spray (*Tr. Picis liq.* f ʒj, *Aqua* f ʒj), to be applied twice a day.

If improvement is not soon apparent electricity may be, also, applied. Place a blunt electrode upon the posterior surface of the velum of the palate, and the other pole, sponge-covered and moistened, over the superior cervical ganglion behind the angle of the jaw; then apply a weak induced current, and gradually increase its strength, until lively sensations are produced.

A Eustachian electrode, consisting of a wire nearly covered by a hard rubber Eustachian catheter, is introduced through the nose into the tube, the sponge electrode is placed over the mastoid process, and the Faradic current is thus sent through the ear. A séance of five to ten minutes every day, of occasionally interrupted electrization, is sufficient for all cases. Electricity in my opinion is valueless in humid inflammation of the tubes; is sometimes beneficial in the proliferative condition; but finds its true sphere in weak and paretic states of tubal and tympanic muscles.

Inflation of the ear by means of the air-bag, without or with the catheter, is sometimes useful in proliferative cases; of signal benefit, where there is much secretion of mucus, and indispensable in paretic states of the palato-tubal muscles. The sudden distension of the tube separates the moist walls, breaks up adhesions, increases the calibre, drives out superfluous mucus, aerates

the tympanum, and stimulates the mucous membrane and muscles to normal action. It will be necessary to use the catheter with the air-bag, whenever inflation cannot be accomplished by the latter alone; and this will occur, when the tube is blocked by thickened mucus, swelling of the mucous walls or lips, cicatricial contractions of the parts, relaxation or paresis of the muscles, growth of large granulations or polypi, and hyperostosis of the bone.

It is considered necessary to use the catheter, when it is desirable to affect one ear only, the other being healthy. Such cases occur frequently. I had a patient under my charge for deafness of one ear, caused by acute inflammation several months before, whose other ear showed no signs of disease, and had a hearing power of $\frac{60}{100}$. It would not have been proper in this case to give a general inflation of both ears every time the diseased one needed air. I, therefore, limited the inflation to the diseased ear by employing the catheter. A moderate artificial inflation of a healthy ear occasionally, generally does no harm, but the risk of exciting a morbid state had better be avoided.

In many persons who apply for treatment of one tube or ear, the other will be found affected in some degree, and it is not necessary to be so particular, but then, even, there must be some limitation, because different stages of a disorder require different treatment. Very often the shape of the nasal passages is such, that they favor the entrance of air into one Eustachian tube in preference to the other. The following variations are observed frequently:

1. Inflation by the air-bag through either nostril will act upon the tubes of both sides.

2. Inflation through one nostril will act only upon the tube upon its own side.

3. Inflation through one nostril will act only upon the tube upon the opposite side.

4. Inflation through either nostril will not dilate either tube, but the air will pass into the stomach, or burst open the palate, and escape by the mouth.

Violent inflations and those which burst open the palate make the pharyngeal muscles lame, and patients will complain, after a

few days treatment, of *sore throat*, depending upon muscular strain. This kind of sore throat I think has not before been mentioned in medical literature; the physician should differentiate it from other varieties. The proper remedy for it is to compress the air-bag with less force and rapidity.

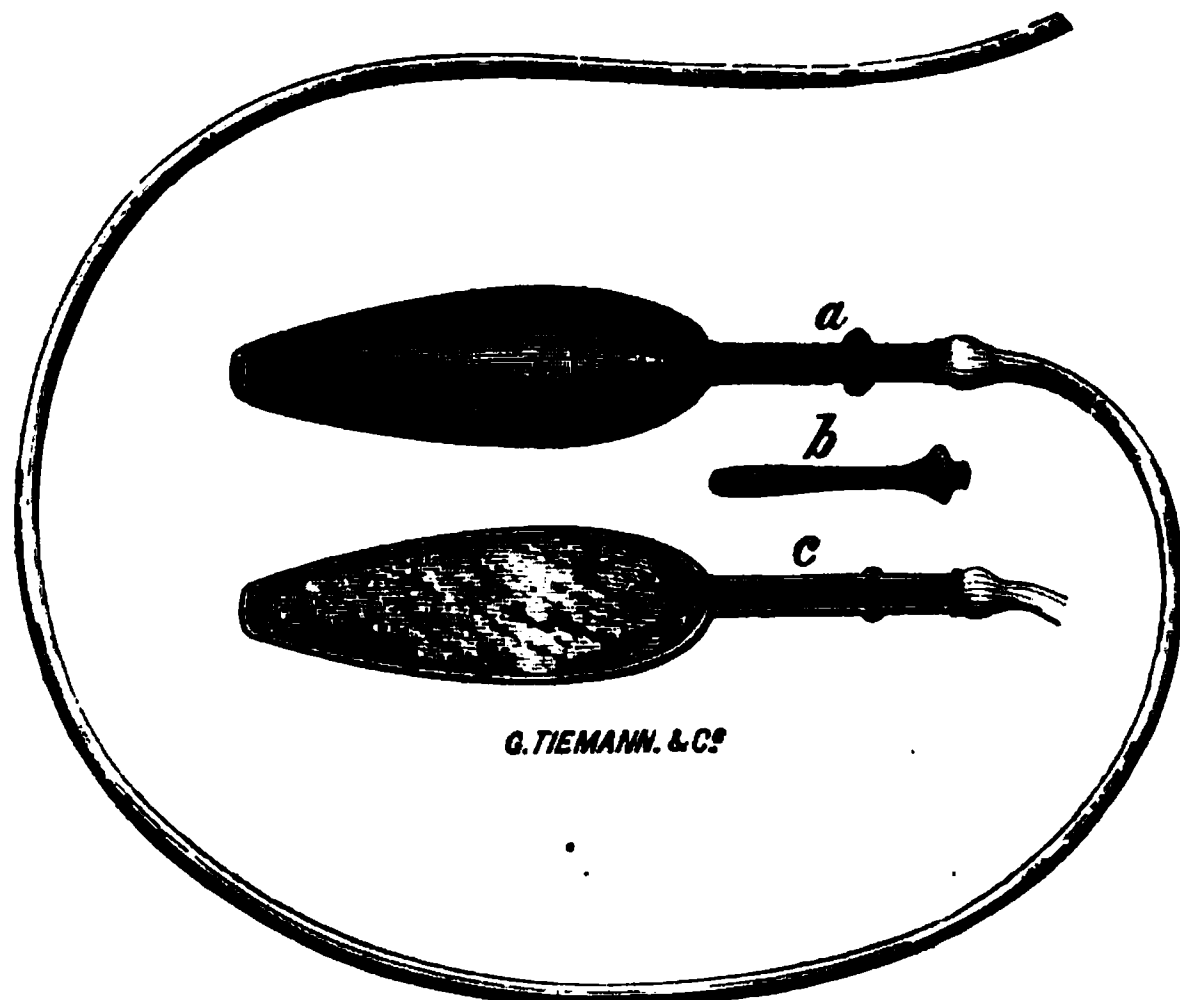
FIG. 112.



INHALER NOZZLE.

Quite a variety of nozzles for the air-bag are necessary to suit all noses. Many cannot endure the hard rubber tube or the olive-shaped nozzle; the glass ones that fit into the nostril, and do not enter the nasal meatus much will prove more agreeable. A

FIG. 113.



BUTLER'S INHALER.

rubber or glass nozzle of appropriate size, containing a piece of sponge, is attached to the air-bag tube, when vapor is to be forced into the Eustachian tube or ear by the blast of air. A bone or vulcanite tip replaces the nozzle, when catheterization is performed.

A silver catheter should be employed for inflating, and generally for medicating the Eustachian tube and ear. It conducts readily, it is easily cleaned and disinfected, it separates agglutinated surfaces, cools and stimulates the mucous membrane, starts the muscles into action, aids in the expulsion of mucus, and exercises the same influence over the morbid condition of the tube that the sound does in gleet.

Roosa says, "We may often very much improve the hearing power of a patient by the introduction of the instrument between the lips of the tube, even, when no air, vapor, or fluid is passed through it."

The statements made above explain why. The catheter should be used with the air-bag then, in a large number of cases. The air-bag should be used, also, where one sound ear does not forbid, because an air blast into the naso-pharynx, stimulates the mucous membrane, exercises the palato-tubal and throat muscles, and aids in the expulsion of mucus.

The severity of the disease will determine the number of inflations to be made at one sitting, the number per week, and, consequently, the number of calls upon the physician. Patients are unwilling and often unable to visit a physician as frequently as they should. A few cases of chronic inflammation of the tube and tympanum need to be seen and treated daily. They are the humid ones, characterized by a great deal of mucous secretion in the pharynx, tubes and tympana.

Air cannot get into the tympanum through swallowing, movements of the jaw, blowing the nose, and the Valsalvian method; though râles may be heard from the superabundant mucus which stuffs and clogs everything. Inflation and catheterization are necessary daily, to clear out the mucus and hinder degenerative changes, and astringent stimulants should be applied as often.

Rarely can a patient with profuse catarrh open the tubes and inflate his own ears. If he cannot come to the office daily, he may try the Valsalvian method once a day at home; failing in this, if he is obliged to remain away from the aurist for days at a time, he ought to be furnished with an air-bag, instructed how to use it, and directed to employ it once a day. This will only help a little, because auto-inflation is always defective, and self-

catheterization is not practicable. I believe these cases will not improve, unless treated by the medical attendant at least twice a week. Four to six inflations should be made at a sitting, in order to remove all the mucus possible, stretch the tube open, get some air into the tympanum, and drive the blood onwards from the congested vessels.

Milder catarrhal cases, in which inflation sometimes occurs spontaneously, ought to have medical attendance every two, three or four days. If the interval between visits is longer, the treatment will be more protracted. I have found by experience, that once a week is not often enough to see such cases.

Two or three inflations at each visit are sufficient. When the tube opens easily, and the tympanum feels very full after inflation, one moderate puff with the air-bag will suffice. It requires nice discrimination to know just what is enough. It should be borne in mind that inflation may injure the hearing, when the tube opens easily and air goes into the tympanum freely. The membrana tympani is pushed out forcibly and its elasticity destroyed by too strong and too frequent inflation.

Inflation is generally required in closure of the Eustachian tube from relaxation or paresis of the muscles, about as often as in mild catarrh, which, indeed, very frequently accompanies it. The catheter is generally necessary as a mechanical accessory, as well as for its therapeutic influence; because filling the pharynx with a puff from the air-bag alone often presses the lips of the tube closer together.

Proliferative cases need the air-bag and catheter about twice a week in the early stages, to expel mucus and stimulate the tissues; in the later stages, to prevent or break up adhesions, hinder contraction, press the blood along in the dilated and inactive vessels, and to favor retrograde changes in the thickened and sclerosed tissues.

The air-bag will be sufficient without the catheter in many of these cases, as the disease is frequently bilateral, and air passes through the tube freely, especially, in aged persons. Care must then be taken not to drive air into the tympanum too forcibly and thus injure the elastic tension of the drum-head. Persons who have practiced the Valsalvian inflation frequently, furnish

examples of flaccid membranes. So do others who obstruct the nostrils too much when blowing the nose. If some cases become worse after commencing treatment, these causes may be suspected. When adhesions or obstructions exist, of course, more force may be expended, but inflation should not be pushed to cause vertigo.

There may be obstruction to inflation from plugs of mucus and exfoliated shreds of membrane. These yield to well-directed efforts at inflation, and escape into the pharynx. After several unsuccessful trials, a few drops of a warm solution of caustic potassium (*Potassii hydras. gr. j, Aqua dest. f ʒj*), or of bicarbonate of sodium (*Sodii bicarb. gr. v, Aqua dest. f ʒj*) should be introduced into the catheter *in situ* by a dropper, the air-bag connected with it by a tube and proper tip, and the fluid blown into the tube. The injection may be favored by inclining the head to the side of the ear which is being treated, and making the patient swallow saliva or water just as the bag is compressed. This injection will dissolve inspissated mucus and clear a way, after one or more applications.

Another common cause of tubal occlusion is the congestion and swelling of the mucous membrane. This diminishes immediately after successful inflation, which may be alone sufficient in mild cases to effect a cure, as I have stated elsewhere; but generally some degree of inflammation will persist until other methods of dissipating it have been employed. In such a state, the air will pass through the tube in a fine stream, it will be felt in the ear by the patient, and heard by the physician with the auscultation tube, but the sound will be slight and indefinite, without or with weak râles, and the patient will not feel that decided thud and fulness, which indicate a good inflation.

For this condition, a few drops of a warm solution of borax (*Sodii biboras. gr. v, Aqua dest. f ʒj*) blown in through the catheter is most appropriate. It is a good solvent for mucus; it cools and soothes the hyperæmic membrane, and favors an exudation, that relieves the engorged tissues and washes out the tube.

After this I like a warm solution of tar (*Tr. Picis liq. ℥xx, Aqua dest. f ʒj*). This contains just enough of the alcoholic and balsamic properties to stimulate and tone up the mucous membrane, and help it back to a healthy state. When the thickening

does not diminish, nor the passage yield to persistent treatment of this kind; above all, if the pharynx is hypertrophic or granular, and blood is seen upon and in the distal end of the catheter after gentle insertion, I think time may be saved, and the patient materially benefited by resorting to astringent injections.

Of these, a warm solution of Zinc sulphate is the best (*Zinci sulph. gr. ij, Aqua dest. f ʒj*), according to my experience. Diluted tincture of Chloride of iron (*Tr. Ferri chlor. ℥xx, Aqua dest. f ʒj*), a solution of Zinc chloride (*Zinci chlor. gr. v, Aqua dest. f ʒj*), and one of Silver nitrate (*Argent. nit. gr. v, Aqua dest. f ʒj*) are sometimes used instead of the zinc sulphate, but have no advantage over it. In some obstinate cases the silver may be tried. The quantity of any of these should always be small.

No one need be afraid that these applications will damage the ear, even, if the astringent does penetrate so far. I am satisfied, if one can judge from objective and subjective symptoms, that I have driven a drop or two of several of the above-mentioned topical remedies into the tympanum time and time again without causing inflammation in a single case.

When Ether and Chloroform excite so little reaction in the middle ear, it is nonsense to assert, that the weak solutions of needed remedies recommended are pernicious. I use them constantly with benefit to my cases, notwithstanding the condemnation of certain authors upon aural disease, and I do not believe any one can treat chronic catarrh of the tube and tympanum successfully without them.

In obstinate cases, the catheter, and the zinc solution ought to be used every day; then, as the lumen of the tube increases and the inflammatory thickening subsides, one of the other fluids may be substituted. I deprecate resort to the bougie until time and patience have been consumed in the way I have indicated. I do not approve of steam or medicated vapors for humid inflammation of the tubes.

It must be evident to the reader, that the middle ear will often receive treatment along with the Eustachian tube, owing to the local and mechanical means employed. In most instances, the tubal treatment is, also, appropriate to the aural condition. Whether it is or not, it must take precedence, because its disease

aggravates, if it does not cause the tympanic disease, and one cannot treat the middle ear until there is free access to it through the tube.

The Eustachian tube is occasionally found impervious, and remains so after employment of the air-bag, catheter and medicaments, and one is unable to say, without further exploration, where and what the obstruction is. The passage may be much contracted, and seem closed when it is not. In case of doubt, a few drops of chloroform should be put in the sponge of the inhaler nozzle, and blown into the tube with the air-bag just as the patient swallows. The vapor will penetrate to the middle ear, when an inflation of air will give no sign, and thus clear up a doubtful diagnosis. The patient's sensations of sudden fulness and lively pain in the ear will be evidence that the chloroform has reached the tympanum. When it enters the tube only a little way, there will be coolness and smarting felt in the tube and upper pharynx, with, perhaps, a little transient dyspnoea. Then total occlusion of the tube being certain, resort must be had to bougies.

Bougies are not to be resorted to hastily, because their use is fraught with some danger. Emphysema of the neck, throat, and larynx has been caused in numerous instances by the instrument, and, even, death has resulted from its careless manipulation.

Spongy granulations and polypoid excrescences at the mouth of the tube must be removed by astringents, caustics, and instruments, as described elsewhere. They sometimes may be pushed aside by the catheter, so that inflation can be accomplished. Relaxation and paresis of the palato-tubal muscles often necessitate a little manœuvering, in order to insert the catheter. Adhesions and cicatricial contractions of the opening yield sometimes to the catheter and bougie. In rare cases, one might be justified in attempting to cut a bridge of tissue or a rigid band, and I have been inclined to operate upon some cases of distorted soft palates, in which the tensor and levator palati muscles were contracted and displaced. Each case is a law unto itself, and surgical principles and cautious judgment must decide the operation. Ob-

struction of the tube is generally at its isthmus, and the cause can only be approximately determined.

Tumors are rare within the canal, and granulations soon yield to the treatment by inflation and injections, so that in an obstinate case one may safely conclude, that adhesions, contraction or hyperostosis is the cause of occlusion. Of these, the last is irremediable.

To test, and sometimes to overcome the obstacle, a good-sized catheter to suit the patient's anatomy should be selected, its distal end filled and smeared with vaseline, and then placed in position. A catgut bougie, slightly tapering at the point, and marked as previously directed, should be pushed through the catheter until the obstruction is reached. Try to force this by gentle pressure. Withdraw the bougie a little and advance it again, turn it around, have the patient swallow several times, while steady pressure is maintained; be patient, light handed, and persevering, as in dilating a urethral stricture, and success may follow.

If one bougie does not succeed, try a smaller one, and again a smaller until the filiform one fails. Then give it up until the tube has been treated awhile with zinc injections and attempts at inflation.

Suppose, as is usual, the obstruction yields a little, what is to be done? Push the bougie in firmly, leave it ten minutes, and then withdraw it. Push it a little farther next day, leave it in awhile, and so continue until the closed part yields, or it is found impossible to proceed farther. It is not safe generally to try to push through a closed tube all at once.

When the bougie enters almost to the mark indicating its near approach to the tympanum, great care must be exercised not to advance it rashly.

The instrument should be pushed gently and cautiously onwards day by day, until a sudden yielding of the resistance gives evidence, that it has passed the obstruction or entered the tympanum. It ought not to be pushed far into the tympanum for fear of injuring it. Intense pain and purulent inflammation of the middle ear have been caused by doing so.

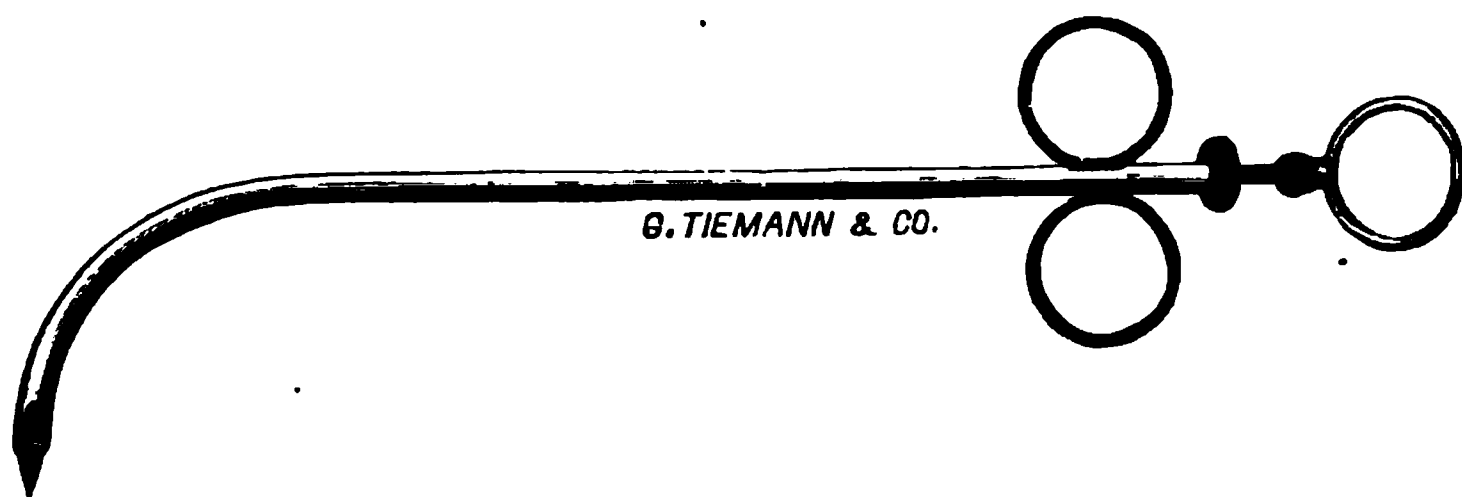
When an obstruction is once passed, leave the bougie in position awhile, then remove it, and try it again the next day.

While this dilatation is going on, the topical application should be continued through the catheter on alternate days. The zinc solution follows the bougie very well.

Inflation must not be attempted the same day, after the bougie has been used for fear of producing emphysema. If this happens through carelessness or ignorance, the throat and larynx must be carefully examined, and the seat of the submucous air found. The mucous membrane over it must be snipped with the scissors, or punctured freely with a bistoury.

Emphysema of the larynx is most dangerous, because closure of the glottis is imminent from it, and it is difficult to reach its seat. Edema of the glottis is, also, not very rare in practice. A special instrument is necessary to treat these two affections, and ought to be in every physician's outfit. Tobold's laryngeal lancet is well adapted to the purpose. It consists of a curved haft with a handle, and a short, sharp, sheathed, cutting point.

FIG. 114.



TOBOLD'S LARYNGEAL LANCET.

A strongly curved bistoury with the blades wrapped with tape nearly to the point has been used, when nothing more suitable could be procured.

As soon as the diagnosis is made, the patient is to be seated erect, the head supported, the throat illuminated, and the tongue depressed. The instrument, guided by the view in the laryngeal mirror or by the finger, should be passed down to the distended tissues, and the mucous membrane freely scarified. The symptoms disappear, as soon as the air escapes from the cellular tissue, and generally no further treatment is necessary. Inflation should be omitted for a few days for fear of a recurrence of the accident.

The proliferative stage or state and the so-called dry catarrh of the Eustachian tube require topical applications different from those applied to the humid inflammations. The fluids and vapors that are of benefit in such conditions of the tube are not contraindicated, when the tympanum is at the same time affected in a similar manner, as is usual. This is fortunate, because in many cases the Eustachian tube permits a free passage to the middle ear, and in old people it is rather too free. When a diagnosis of non-secretory, or proliferative inflammation, is made, the aurist

FIG. 115.

THE LABYNX.

may inflate as directed above, use the bougie if found necessary, inject medicinal solutions through the catheter, and resort to steam and medicated vapors.

Glycerine is one of the most valuable agents for dryness of the mucous membrane, which often exists with the granular and atrophic pharyngitis. It keeps the parts with which it comes in contact soft and moist; dissolves inspissated mucus; stimulates the mucous membrane to healthier action; favors capillary drainage and epithelial exfoliation; permeates and renders flexible the drum-head, the articulations of the ossicles, and adventitious bands; aids the movements of the muscles in their delicate sheaths, and improves the hearing.

It may be used undiluted, and dropped upon a thickened membrana tympani, while the head is held for some minutes bent to the opposite side; and be sprayed, brushed or injected into the mouth of the Eustachian tube. I prefer a mixture of equal parts of glycerine and water for these purposes, and to inject into the tube and tympanum. I have proved it to be as beneficial as the

undiluted, and it is much easier atomized and injected through the catheter. In the cases I am considering, it ought to be applied to the drum-head and blown through the catheter into the tube at every visit until improvement ceases; then it should be used once a week in alternation with other local remedies.

Muriate of ammonium in solution (*Ammon. murias* gr. x, *Aqua dest.* f ʒj) is an excellent solvent of dried mucus, and stimulant of the mucous lining of the tubes. It accelerates the nutritive changes in the tissues, the exfoliation of abnormal epithelium, and the secretion of mucus, and thus diminishes the thickening, hypertrophy, and adhesions, which are present in sclerosis. It is not suitable for the drum-head, but should be introduced through the catheter by a puff of the air-bag. This ought to be done every two or three days for many weeks, perhaps, months; until it is evident that no further effects can be expected; but a glycerine injection should, also, be made once a week, to keep the parts soft and flexible and the hearing improved.

An Iodine and Ammonium mixture (*Tr. Iodini* ℥x, *Aqua Ammon.* ℥v, *Aqua dest.* f ʒj) possesses greater stimulating and alterative powers than any topical remedy yet mentioned. The ammonium dissolves thickened mucus, increases the mucous secretion, and aids epithelial growth. The iodine is stimulating to the mucous membrane of the tube and ear, but its value depends upon its alterative properties, by which it promotes the degeneration and absorption of morbid deposits. This mixture is a very good one for the exhibition of iodine in solution, and a few drops should be forced into the tube through a rubber catheter at each sitting. In some cases, it will reach the tympanum and affect its lining, as it does that of the tube. Like the other remedies, it must be used for some time before any decided effects will be noticed.

Balsams exert a soothing and stimulating influence upon the mucous membrane. They are frequently useful in proliferative changes in the tube, when the disease is not far advanced; and, especially, in senile cases, where the tubes are somewhat enlarged and the secretion almost nothing.

A balsamic solution may be alternated with the diluted glycerine with advantage.

The tar solution may be used at times, but I prefer a combination which I saw used in Paris. I call it the Benzoin mixture. It consists of benzoin, tolu, myrrh, and water (*Tr. Benzoini* ℥iij, *Tr. Tolutani* ℥ij, *Tr. Myrrhæ* ℥j). The mixture should be kept at hand, and five drops added to a teaspoonful of water, when one wishes to use it. Some of this is to be introduced by a pipette into the catheter in position, and then forced in as usual with the air-bag.

It may, also, be sprayed against the mouth of the tube, though the precipitate of gum in the water generally clogs the capillary tubes after awhile.

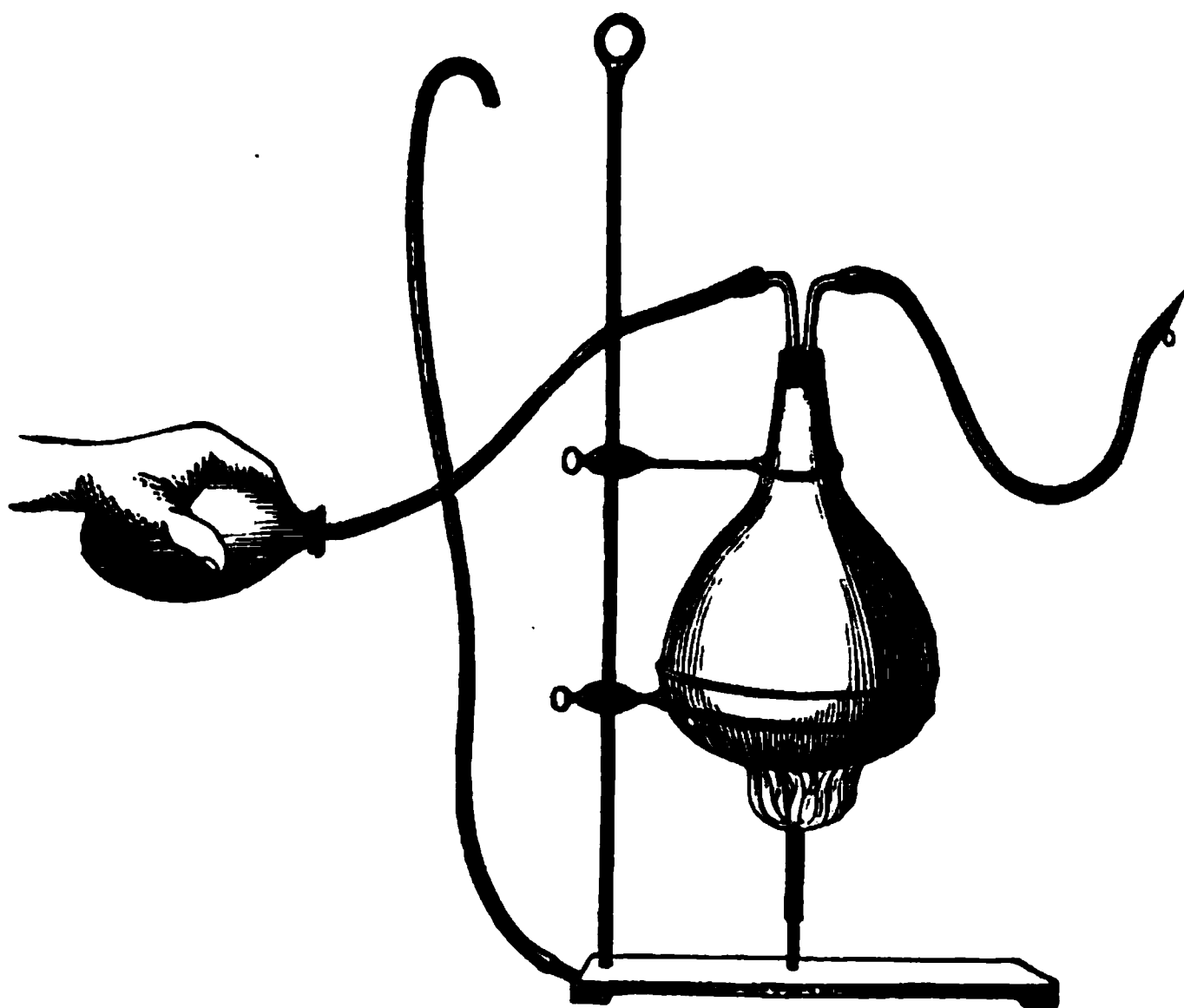
These are all the fluid applications that I can recommend in the proliferative state.

Steam is recommended by some authors and condemned by others, as a remedy for chronic inflammation of the tubes. I have employed it quite frequently in the long-standing proliferative cases, having adhesions of the membrana tympani, dry scaly external canal, considerable squeaking or rasping tinnitus, and pervious Eustachian tubes with dry linings, indicated by an absence of moist râles, and a nearly healthy pharynx. Steam is of decided benefit to stimulate the mucous membrane and restore its secretion. It may be applied twice a week, alone, but I prefer alternating it with the glycerine injection, though the use of the latter will vitiate, of course, the evidence in regard to the value of the vapor.

A special apparatus is necessary to steam the ear. A small Florence flask with a rather large opening should be tightly fitted with a rubber stopper, perforated by three small metal tubes. A piece of rubber tubing should connect one of the metal tubes with a Politzer air-bag; another piece of tubing should connect another tube with a suitable rubber catheter by a vulcanite or bony tip fitting into it, so that it may be disconnected at pleasure; the third tube is to be used for the introduction of fluid and the escape of steam, during the generation of which it must be closed by a cork with a fine hole in it. The flask is to be supported by a stand upon a table, and heated by an alcohol lamp of medium-sized flame, which must not come above the level of the water, or the glass vessel may be broken.

When steam issues from the safety-tube, the air-bag should be compressed several times until it escapes from the tip in jets. Then a vulcanite catheter having been introduced, as a metal one becomes too hot, the tip is connected with it, and the air-bag compressed sharply. The tip must be immediately disconnected a few moments, then connected again and another puff given, and this may be done half a dozen times or more. If

FIG. 116.



STEAMING APPARATUS.

these directions are followed, there need be no fear of scalding the pharynx. The catheter and apparatus are then to be laid aside, and the patient permitted to cool off awhile before going into the open air.

Every man who has the knowledge, skill, and patience to treat aural diseases will be ingenious enough to construct a steam apparatus for himself.

Chloroform and Ether can be introduced into the tubes from the apparatus, minus the lamp, and the vapor of iodine, camphor or acetic acid, after the application of gentle heat.

The use of Chloroform in diagnosis has been mentioned; it is employed to a limited extent for its stimulating properties. Ether is preferable to chloroform to stimulate the mucous membrane, and to diminish and mitigate rebellious and distressing tinnitus. Tincture of Camphor, and Acetic acid are used for the same purpose. Tincture of Iodine is introduced as a stimulating alterative.

The inhaler nozzle with air-bag is a much less cumbersome apparatus to apply these medicinal vapors, than the steam apparatus, and will answer every purpose, provided there is no objection to the vapor coming in contact with the Schneiderian mucous membrane.

A little of the selected fluid is dropped upon the sponge, the nozzle is fitted into one nostril, both nostrils are closed tightly by the fingers, and the air-bag is compressed once or twice as the patient swallows. This forces the medicated air into the nose, naso-pharynx, Eustachian tube, and the middle ear.

The employment of fluids and vapors in the manner described must not be considered a substitute for inflation. The air-bag should be used as directed, just before applying a local remedy, in order to clear the tube as much as possible, that the medicine may come in direct contact with the diseased membrane.

The internal medical treatment of chronic inflammation of the tube is modified by morbid states in associate parts.

Disease of the nose, pharynx or throat will often present indications for medicines, which overshadow the tubal symptoms, and must not be disregarded. I have elsewhere stated, that these parts must be approximated to the normal condition, before one can expect to diminish much or to arrest inflammation in the tubes and tympana. The proper medicine should be selected from a consideration of those given under the predominant disease.

In some few cases, the symptoms and pathological state connected with tubal and tympanic disease will be prominent, when the nose and throat furnish nothing definite in relation to internal remedies. The particular indications for these I have grouped under the treatment of the tympanic disease, which must now be considered.

Treatment of Chronic Inflammation of the Tympanum has been in a great measure disposed of in treatment of chronic inflammation of the Eustachian tube. The chronic catarrhal and proliferative inflammations of the middle ear demand the use of the air-bag, the catheter, and the local emollient, stimulant, astringent, and alterative vapors and fluids given in the previous section.

They should be applied with the same frequency and force as there recommended, and the remedies should be of the same strength. The physician should pay particular attention to the variety of the inflammation, and give each state its own proper remedies.

It is an established fact, that vapors and fluids can be introduced into the tympanum through the catheter in the manner described when the Eustachian tube is pervious, and clinical experience has demonstrated that they exercise a marked salutary influence upon the diseased mucous membrane and the submucous tissues. Roosa approves heartily of this method of treating the diseased middle ear, and has no doubt of the entrance of medications therein, though his therapeutics are somewhat limited. Burnett echoes the opinions of his German teachers against the use of fluid applications in the interior of the tube and tympanum, expresses doubt about their getting so far as the latter place, and thinks, if they did, they would do more harm than good, as it is "an air cavity, and resents the presence of fluids." He approves faintly of the use of the vapor of chloroform, ether, and iodine.

I prefer the therapeutic boldness of Roosa, to the pathological nihilism of Burnett, and, early convinced by precept and example of the value of topical medication of the tympanic lining, and the feasibility of introducing vapors and fluids into the cavity, I have employed them with confidence and success. They can be introduced; they will do good; they may occasionally cause a little fulness and pain, rarely, more serious symptoms.

There is another use for an injection into the tympanum, which has not been mentioned in this connection. It is for the purpose of softening and washing out deleterious matter. In rare instances, peculiar symptoms, as variations of hearing, sudden and distressing tinnitus, and dropping sensations in the ears will in-

dicates the existence of grumous fluid, clotted blood, dried mucus or organized fibrin in the tympanum; and, occasionally, sharp eyesight may detect it through a not much altered membrana tympani.

When soaking the membrane in glycerine and water ten minutes, the introduction of steam and dilute glycerine, and strong inflation *via* the tube, every day for some time, fail to remove the offending substance, a vertical incision, 3 to 5 mm. long, should be made with the myringotome in the posterior inferior quadrant of the drum-head, taking care not to go deeply enough to injure the inner wall of the tympanum.

If the substance has considerable consistency, as a blood-clot or dried mucus, and there are no anatomical reasons against it, the incision may be made at its location. In general, this cannot be determined, when the previous directions had better be observed. After the incision, the ear must be syringed gently with tepid water, and a catheter full forced through the tube and ear into the external canal by a few blasts of the air-bag.

This operation should be repeated daily a few times, and, if the substance is not thus removed, the sodium or potassium solution should be injected through the Eustachian tube, and syringed through the external canal. The dilute glycerine may be applied in the same manner afterwards, should the case prove refractory. If the opening remains awhile, advantage may be taken of it to introduce appropriate medicines for the diseased mucous membrane.

Solutions of sulphate of zinc, and nitrate of silver, and the diluted tar tincture are suitable for the humid; and diluted glycerine, and solutions of muriate of ammonium, iodine, and benzoin for the proliferative cases. The proportions ought to be the same as already formulated for use through the catheter.

The incision in the membrane will generally soon heal, and then the usual treatment may be continued.

Sometimes acute inflammation may be excited by these local applications, and its treatment must be substituted. If this terminates without sequelæ, it will be found that the chronic trouble has been considerably ameliorated by the increased secretion and liquefaction in the tympanum.

The membrana tympani is so thin, it seems reasonable that medicated fluids should pass through it and affect the lining of the tympanum. Glycerine both diluted and pure has been applied to the drum-head in many cases of chronic deafness with good effect. It is not suited to the humid inflammations, but to the proliferative and dry cases.

When the external canal is dry and its cerumen diminished; when the drum-head is dry, thick, opaque, and distorted by adhesions and contractions, and there is a suspicion of mucous masses within the tympanum, warm glycerine and water should be dropped in the ear daily, and allowed to remain for ten minutes.

A little vaseline smeared upon the canal walls is the best representative of cerumen. It softens and soothes the scaly skin, keeps out dirt, and should be renewed often.

The presence of a great deal of secretion in the tympanum and tube with a soggy and congested drum-head has been mentioned in some cases of catarrhal inflammation. The amount of secretion can be diminished, and the tympanic disease modified favorably without injury to the drum-head, by instillation of five or ten grain solutions of zinc sulphate. This strength is necessary to set up decided osmotic currents. I am experimenting with other remedies, introduced into the tympanum by osmosis, and hope to present serviceable indications and reliable statistics at some future time.

I warm a common dropper over the argand burner, fill it half full of the desired solution, warm it again until a drop exudes from the point, drop a little in the palm of the hand to test the temperature, incline the patient's head so that the treated ear is upward, and drop the fluid into the meatus. I leave the remedy in from five to ten minutes, then hold a small cup under the auricle, tip the head towards this side, catch the escaping fluid, and wipe the ear and neck with a towel.

Inflations of the tympanum by the air-bag without and with the catheter play an important rôle in treatment. Their use in aerating the cavity, expelling mucus, forcing in medicated vapors and fluids, restoring the plane and mobility of the membrana

tympani, aiding the hearing, and promoting curative action, has been dwelt upon in treatment of the Eustachian tube.

There are other effects of inflations, which are too important to be neglected. They relieve the uncomfortable fulness in the ear, mitigate or check tinnitus, banish vertigo, calm nervous irritation, and ameliorate a distracted mental state. Moderately strong inflations have a mechanical action not to be ignored. They exercise compression upon the dilated vessels of the tympanum, and force contraction; break fibres and bands of inflammatory formation; tear adhesions between the drum-head and ossicles, and walls of the ear; free and stretch hampered and contracted muscles; loosen the stiffened articulations, and break up anchyloses. These conditions are present in many cases of long-standing aural inflammation, especially, in the proliferative stage or variety, and upon their betterment or removal depends to a certain extent the improvement of the hearing.

When the ossicles are immovable, the injected air will act with greater force than usual upon the segments of the membrana tympani, and the physician should not continue his inflations too long nor make them too powerful, for fear of destroying its elasticity or rupturing some thinned and atrophic portion.

Several inflations should be made at each visit, once or twice a week, and the other treatment steadily and hopefully continued. Siegle's instrument, so useful in diagnosing adhesions and free segments of the membrana tympani, is sometimes applied for the purpose of restoring the drum-head to its proper position, and breaking up adhesions in the middle ear. It is very troublesome, and entirely inadequate for the purpose, notwithstanding the encomiums of some authors.

OPERATIONS upon and through the membrana tympani are occasionally performed for the relief of progressive deafness, and chronic inflammation of the tympanum.

Certain approved surgical measures must now be considered for distortion, depression, and adhesion of the membrane, and contraction of the tensor tympani muscle.

Accidental rupture of the membrana tympani in some cases of chronic deafness was observed by physicians of the last century to improve the hearing, and this improvement continued as long

as the opening remained. It was a natural conclusion, that artificial perforation of the drum-head in similar cases would have the same effect as the accidental, and so it proved. The example furnished by nature was imitated by art; the membrana tympani was incised for deafness by regulars and charlatans, and accident thus furnished an established operation in surgery, as it has done in many other instances. There was very little attention paid to diagnosis of the aural condition demanding perforation of the membrane. Surgeons were ignorant of the methods of diagnosis and of the refinements of aural pathology, which make modern practice nearly an exact science; and, hence, any and every case of deafness was treated by puncturing the membrane. As only a very few cases were amenable to such treatment, numerous failures to improve the hearing resulted; the operation fell into disrepute amongst educated surgeons, and was for awhile performed only by the disreputable and dishonest.

Increased knowledge of the anatomy and physiology of the ear, and great improvement in methods of diagnosing pathological states have enabled modern practitioners to establish data by which one may decide the feasibility of an operation, and the probability of improving audition.

Indications for operation in chronic progressive inflammation of the tympanum, when other treatment fails to improve the hearing and to relieve discomfort, are as follows:

1. The Eustachian tube remains closed in spite of treatment, the drum-head being depressed, and morbid aural symptoms prominent.

2. The presence of mucus, blood, fibrin or a foreign body in the tympanum.

3. Atrophic thinning and pouch-like bulging of portions of the membrane.

4. Thickening, hardness, stiffness, and slight mobility of the membrane.

5. Cicatricial folds, causing contraction and distortion of the membrane, diminution of its mobility, and frequent attacks of hyperæmia.

6. Prominence of the anterior and posterior folds; depression

of the membrane, with adhesion to the ossicles or the inner wall of the tympanum.

7. Malposition of the ossicles, and unfortunate attachments of a perforated drum-head, causing tinnitus, vertigo, and fugitive pains.

8. Distressing tinnitus which all the resources of art cannot otherwise relieve.

9. Contraction and rigidity of the tensor tympani muscle, with depression of the membrane, and symptoms of pressure upon the labyrinth.

Contraindications for operation are as follows :

1. The membrana tympani is almost entirely adherent to the inner wall of the tympanum, so that there is no outward movement during inflation and the use of Siegle's speculum.

2. The deafness has resulted from cerebro-spinal disease, and the tympanum is little affected.

3. The tuning-fork, vibrating upon the vertex, shows great impairment or total paralysis of the auditory nerve.

4. The patient is feeble from ill-health or old age.

5. The disease is hereditary, of very long continuance, and there are unmistakable signs of advanced sclerosis, with hyperostosis of the temporal bone.

It is plain enough that an exact diagnosis of the aural condition must be made, and a clear idea of what tissues need cutting to give greater freedom of action to the auditory apparatus, before the knife should be taken in hand.

The simple incision in the inferior, anterior or posterior quadrant of the drum-head, to let in air, favor the escape of improper substances, or diminish atrophic thinning and pouching, should be made under good illumination from the head-mirror, through a thin hard rubber speculum, by means of the myringotome, fixed at an angle in a Weber-Liel handle. The cut should be about 2 mm. long, and 2 mm. distant from the manubrium, but its height may be varied according to circumstances.

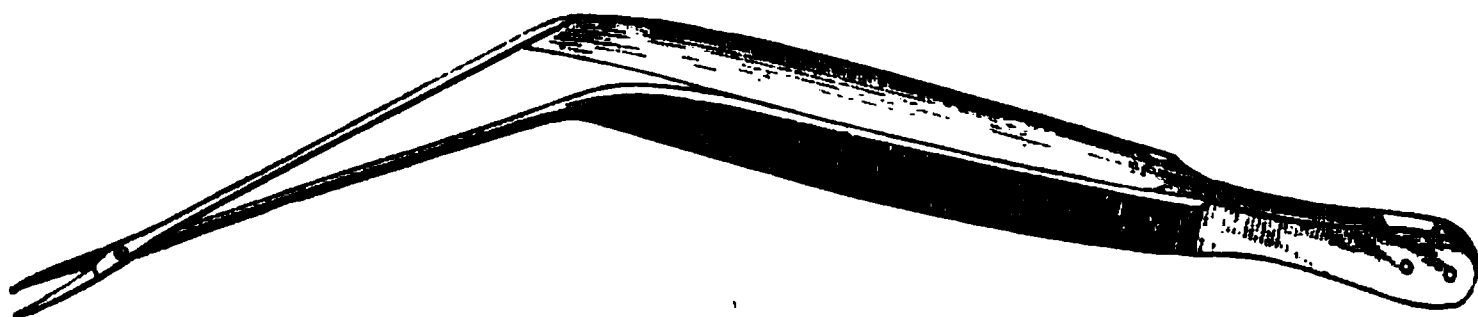
Cicatricial folds and bands that distort the membrane and drag upon the manubrium should be cut across their long axis. The posterior fold, between the short process of the malleus and the periphery, becomes prominent and rigid when the membrane is

much depressed, and both Lucae and Politzer recommend that it should be incised transversely. A sickle-shaped needle, fixed in a Weber-Liel handle with the cutting edge upwards, should be passed through the drum-head below the fold, and the cut made upwards to avoid injuring the chorda tympani nerve.

Thickening and sclerosis of the membrane, permanent occlusion of the Eustachian tube, and distressing, obstinate tinnitus, require an incision in the inferior posterior quadrant, 2 mm. long, parallel with and 2 mm. behind the manubrium. If pain occurs and inflammation threatens after making an operation, the hot douche should be used, and Aconite administered internally.

It is desirable and generally necessary to keep the perforation from closing, and many methods have been in vogue to prevent it. One way is to dissect out a triangular segment of the membrane—a difficult, severe, and sometimes dangerous operation. One incision is made from the umbo at the manubrium down to the lower margin of the membrane, another from the umbo to the posterior margin; the flap is then seized by delicate angular for-

FIG. 117.



SIMROCK'S AURAL SCISSORS.

ceps, and separated from its peripheral attachment by Simrock's scissors, or by a probe-pointed knife fixed in a Weber-Liel handle. This myringotomy of Gruber is condemned by Voltolini, who rather exaggerates its dangers.

In a case operated upon by the former distinguished author, the opening remained after a period of five months.

Another method of maintaining an opening is by amputating the handle of the malleus, as proposed by Wreden, but the operation is unjustifiable, and I will not describe it.

Catgut bougies, and laminaria and sponge-tents, placed in the incision to keep it from closing, have had their advocates, but they are now considered impracticable.

Politzer's eyelet is the best and only thing now used for maintaining an opening in the membrane. It is made of hard rubber or metal, is spool-shaped, perforated longitudinally, and has a piece of silk attached to it with which to draw it out. It is buttoned into a single incision behind the malleus, and the silk is left in the external canal. Politzer has invented a delicate and peculiar angular forceps to fix the eyelet in position. The eyelet upon the forceps is placed in the incision, and a slight pressure of the angle of the forceps liberates and leaves it secure.



POLITZER'S EYELET AND FORCEPS.

The eyelet must be placed in position gently, else injury may be done to the ossicles, and adhesions favored between the membrane, the ossicles, and the walls of the tympanum. If the eyelet does not touch the inner wall of the tympanum, it causes no pain; otherwise severe pain may ensue. The membrane becomes red, pus shows around the foreign body, the lips of the wound tighten around the eyelet and hold it fast; but inflammation may follow in the middle ear, and pus flow out of the opening. A drop of glycerine in the eyelet will dissolve away plugs of pus and epithelial debris, and aid in keeping the opening free.

The consequent inflammation must be treated in the usual manner, and between the times of dressings a pledget of cotton must be placed against the eyelet to keep it from being pushed outwards. Not unfrequently it is displaced outward by the flow of pus, and by blowing the nose. After the reactive symptoms have subsided, the eyelet often improves the hearing and arrests tinnitus.

It is difficult to fix the eyelet in place, more difficult to maintain it in position, and most difficult to keep its opening clear of mucus and epithelium. It sometimes occasions severe neuralgic

pain, and may fall into the tympanum and excite violent inflammation. For these reasons Politzer's little invention is now seldom used.

A membrane perforated by disease sometimes heals and becomes adherent to the ossicles and inner wall of the tympanum in such a manner, as to cause distressing symptoms and require an operation for relief.

An imperforate membrane sometimes forms adhesions with the ossicles and promontory of such a nature, that an operation would seem to promise an improvement of the condition and the hearing.

These operations, which consist in dissecting the membrane from its abnormal attachments, necessitate special instruments and great skill in manipulation.

Dr. Prout, of Brooklyn, N. Y., whose course of lectures upon aural diseases I had the pleasure of attending in 1869, has performed several operations of this character; but so skilful an operator may do surgical operations, that many others should only think about.

He makes use of a very small knife which he describes, "The blade is bent on the flat at an angle of forty-five degrees; it is triangular in shape, about one and a half lines long, and three-fourths of a line broad, sharp at the point and cutting at both edges. The shank is three inches long, of which the inch next the handle is not tempered, that it may be bent to any desired angle. The handle is eight-sided, that it may be rotated between the thumb and finger in using it, and is two inches long."

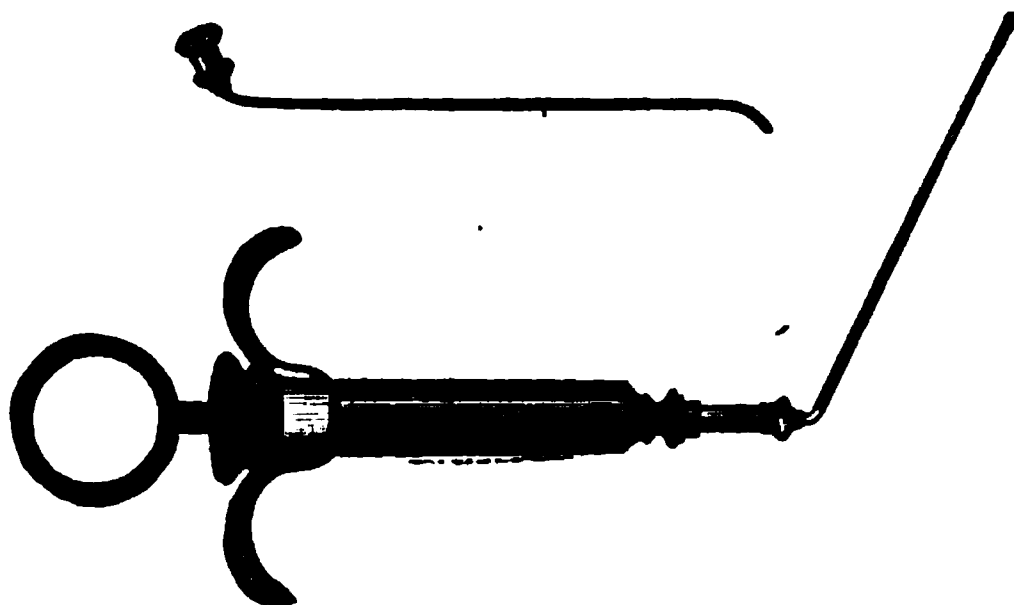
The patient is etherized, the head supported, the membrane illuminated by the head-mirror, the knife shank bent at an angle, and its blade drawn around adhesions until all obnoxious bands are incised and the membrane is free. Blake's middle-ear syringe will be found useful in washing out the tympanum in this and other operations upon the membrane.

One patient before operation had unbearable tinnitus and heard medium voice at ten feet. Immediately after the operation, the tinnitus had ceased, and she heard medium voice at thirty feet. The not severe pain was relieved by the warm douche, and a

slight purulent inflammation for a week afterwards was treated in the usual manner.

One year after the operation, the opening in the membrane remained, the middle ear was dry, and medium voice was easily heard at twenty feet.

FIG. 119.



BLAKE'S MIDDLE-EAR SYRINGE.

One cannot expect such a good result in all cases, but when everything else has failed to give relief, and symptoms demand interference, it is comforting to feel that all hope is not lost, and that it is proper to venture upon this delicate operation.

The tensor tympani muscle has a tonus and contractility like other muscles. It is subject to paresis or paralysis, in connection with the same affection in the palato-tubal muscles, and can be recognized by deafness, and free swinging of the malleus and drum-head. The muscle becomes contracted temporarily or permanently in many cases of chronic inflammation of the tympanum. Irritation in the tympanum, Eustachian tube, pharynx, soft palate, and, probably, in other parts excites frequent contraction of this delicate muscle. Continued irritation and frequent contraction lead to hypertrophy, tonic spasm, permanent shortening, rigidity, and, finally, to fatty degeneration.

These conditions are favored by closure of the Eustachian tube, the consequent rarefaction in the tympanum, inward pressure of the membrana tympani, and the denser air upon its external surface; but they occur without these aids, the passage of air through the tube to the drum being unobstructed. They are, also, favored by gradual contraction of the fibres and bands of morbid connective tissue in the tympanum, which drag the drum-

head inwards, clog and hamper the action of the ossicles, and envelop and hinder the movements of the slender tendon of the tensor. It is probable that simple closure of the tube alone, as well, as proliferative changes in the tympanum, could they exist without other morbid changes, would induce shortening and rigidity of the tensor tympani.

It is certain that this little muscle drags in the manubrium, destroys the harmonious action of the ossicles, induces catarrh of the mucous membrane, increases the intra-labyrinthine pressure, causes deafness, distressing tinnitus, vertigo, and ultimate atrophy of the terminal filaments of the auditory nerve.

Cutting its tendon has, therefore, become a legitimate operation in surgery, after other means of relief have been tried with indifferent success. If inflation will restore temporarily the malleus handle to a normal position, of course, one should persevere in the usual methods of treatment, leaving tenotomy as a *dernier ressort*.

The manubrium is pressed or dragged inwards in various ways, which have been sufficiently dwelt upon. It is necessary to diagnose depression due to contraction of the tensor tympani, from that depending upon other causes, before proceeding to operate.

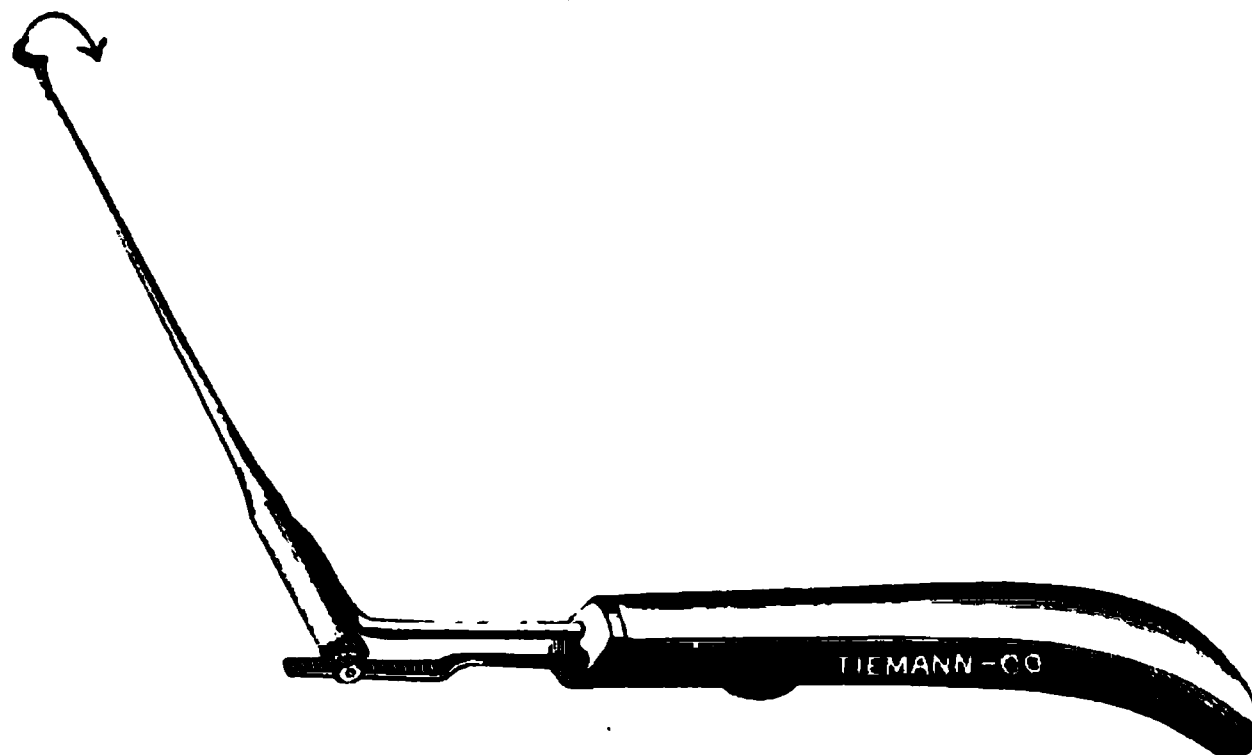
The reader will remember that the tendon of the tensor tympani muscle leaves the ostium of the processus cochleariformis, passes across the tympanum high up, and is inserted into the anterior, inner edge of the manubrium. When the muscle is contracted, the malleus handle is drawn inwards and twisted upon its long axis; the posterior border is sharp and prominent; the short process stands out boldly; the posterior and anterior folds show cord-like; the membrane behind the manubrium is nearly in the same plane as the bone; but anterior it is depressed, and forms a dark concavity, that resembles a perforation. It is easy to recognize the difference between this sharp-edged, fore-shortened manubrium, and the broad, flat, thickened appearance seen in depression from non-muscular causes; but frequently both inflammatory adhesion, and contraction of the muscle exist together, and then diagnosis is difficult.

Tenotomy of the tensor tympani muscle was suggested by Hyrtl, and first performed by Weber-Liel, who has an exalted

opinion of its benefits, not universally agreed to upon this side of the water. His method of operating is rational.

The head is fixed in proper position by a head-rest; a thin rubber speculum is inserted in the canal, and the parts are well illuminated. An anæsthetic is not considered necessary, as the pain is not severe. Weber-Liel's peculiar tenotome is introduced down to the membrana tympani, its hooked blade is passed through the membrane about 1 to 1½ mm. downward and forward from the short process of the malleus. The instrument is then pushed a little inward, its handle moved downward and forward, and the hook grasps the tendon. The handle is now turned a little more towards the patient's face; a gentle pressure is exerted upon its

FIG. 120.



WEBER-LIEL'S TENOTOME.

hook; the button connected with the cog is slipped along enough to turn the hooked blade one-quarter around its axis; and a crackling and yielding will indicate that the tendon has been cut.

The button is then slipped back to its former position, which turns the knife, and the instrument is cautiously withdrawn. Care should be exercised to keep the hooked blade in the anterior portion of the tympanum, close to the inner surface of the manubrium, and upon a level with the incision, in order to avoid injury to the chain of ossicles, the chorda tympani nerve, and the inner wall of the tympanum.

Dr. Weber-Liel has performed the operation more than 300 times.

Dr. Burnett says: "I have had the great pleasure, as well as the privilege, of seeing Dr. Weber-Liel perform this operation, and although its performance with the inventor's instrument seems to have been difficult for most of those who have attempted it, Dr. Weber-Liel certainly performs the operation with ease. . . . He insists on the necessity of the greatest previous practice on the cadaver before the operation is attempted on the living subject. He rejects the assertions that the operation is in any way dangerous to life or detrimental to the amount of hearing still existing anterior to the operation. The best result of the operation, he thinks, has been the quelling of the tinnitus aurium; greater benefit to hearing would accrue, if the tendon were cut at a much earlier stage than heretofore deemed necessary."*

In most cases this operation is impracticable, because the membrana tympani is so depressed in front of the manubrium, that it cannot be perforated without injuring the inner wall of the ear.

Dr. Frank substituted a simple knife, fitted at an angle into a Weber-Liel handle, for cases in which the anterior wall of the external canal curved backwards much, and permitted only a very limited view of the anterior portion of the drum-head. A curved sickle-shaped knife is used now in preference to the cumbersome instrument of Weber-Liel.

Each operator has a knife fashioned according to his own notion, but generally it is some modification of that used so skillfully by Professor Gruber.

Most tenotomes have unnecessarily sharp points for perforating the membrane; they endanger deeper structures, and I have always dreaded to use them.

Dr. Green, of Boston, Mass., must have had this same feeling, for he has had a sabre-like knife made, curved a little on the flat, and having a rounded blunt end.

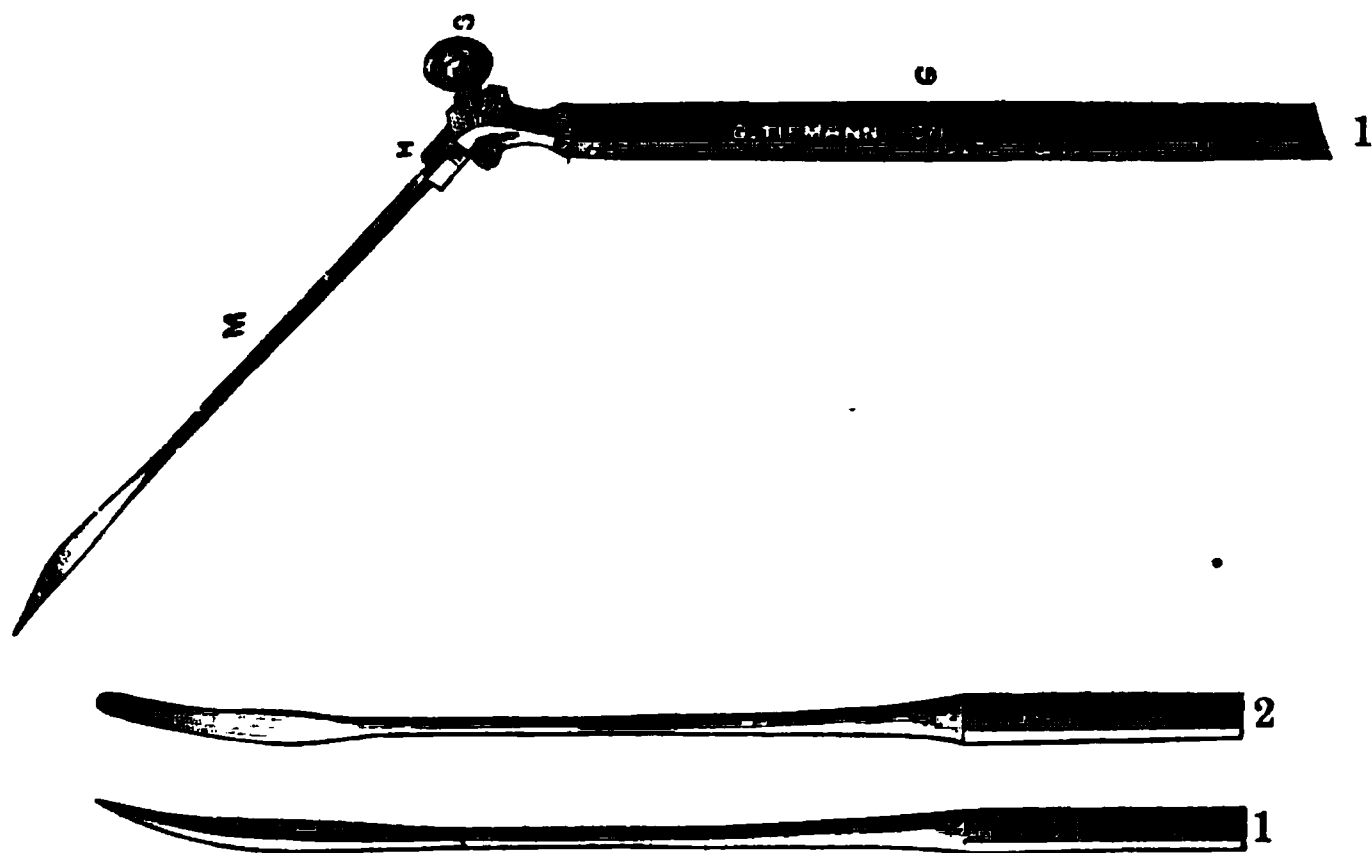
Dr. Hartmann, of Berlin, uses a sickle-shaped tenotome, strongly curved on the flat, and fitted into the Weber-Liel handle.

It is necessary for obvious reasons to have a pair, curved in

* The Ear; Its Anatomy, Physiology and Diseases. C. H. Burnett, A.M., M.D., etc.; pp. 421-425.

opposite directions, with the cutting edge upward or downward, according to the operation determined upon. I think this knife suits the requirements best, but I have had mine made with dulled points, to lessen the risk of injury to other parts than those intended, and I make the incision in the membrane with a myringotome or a cataract needle before introducing the tenotome, as practiced by Schwartze.

FIG. 121.



TENOTOMES.—1, Gruber's; 2, Green's.

Professor Gruber early modified the method of Weber-Liel, and others have followed his example.

Dr. Green prefers to incise the membrane behind the malleus near the short process, and to cut upwards.

Dr. Pomeroy makes an incision near the end of the manubrium, and, also, cuts upwards until the tendon is reached and severed.

Burnett has summarized Gruber's reasons for these different methods. "The rostrum of the *semicanalis musculi tensoris tympani* varies in its position in the tympanum, being sometimes over the anterior segment of the upper arch of the oval window (or it may be over the window), and in some cases it may be over the posterior segment of the oval window. The direction of the tendon, as it passes from the *rostrum cochleare* to the handle of the hammer, must vary greatly, according to the position of the former bony process, and accordingly the handle of the hammer,

in cases of retraction, will have a variable appearance. If the *rostrum cochleare* is placed far backward, the hammer will appear drawn more backward and inward, than if the rostrum is situated further forward, when the handle of the hammer will appear to be drawn directly inward. In the latter case, the anterior segment of the membrana tympani will not appear to be as large, as it does in the former case, where the handle is apparently drawn far backward and upward.

“Hence, Gruber concludes, that no positive rule can be established respecting the choice of a point for incision most likely to reach the tendon of the tensor tympani muscle; but the variable relations of the membrana tympani, and, especially, the position of the manubrium of the malleus, must aid in deciding where the incision should be made.”*

In performing the operation, the head should be firmly supported, a self-retaining speculum adjusted, the membrana tympani illuminated by the head-mirror, and an incision made with the myringotome, 2 mm. long, a little below and just behind the short process of the malleus. Hartmann's tenotome, with the point blunted, should then be inserted through the wound, having its concavity towards and hugging the manubrium, and its cutting edge turned upwards. A slight pressure and gentle sawing, drawing motion will cut the tendon, and the chorda tympani if reached will be pushed upward and remain uninjured, provided the pressure and movement of the instrument is arrested, as soon as the snapping sound caused by the tenotomy is heard. It matters very little if the nerve be cut, as its function is not important, and its abolition causes no apparent disturbance.

I cut the nerve once in an operation for caries, and the symptoms which ensued, corresponded with those recorded by several authors. There was momentary lingual shock followed by tingling and numbness in the corresponding side of the tongue which continued some hours. Sapid substances, as borax, salt, and sugar were felt when placed upon the paretic border of the tongue, but could not be distinguished one from the other, even,

* The Ear; its Anatomy, Physiology and Diseases. C. H. Burnett, A.M., M.D., etc.; pp. 423-424.

when entirely dissolved. Slight numbness continued three days, then gradually disappeared; the taste remained in abeyance upon the side of the tongue for a long time, but the patient was unconscious of its loss.

Great caution should always be exercised in every operation upon the drum-head. When the incision is made in front of the manubrium, there is liability of injuring the ossicles; when behind, the stapes may be broken, the foramen ovale perforated, or the carotid artery cut, if its osseous canal is incomplete, as occasionally happens.

Immediately after the operation, blood runs down the membrane outside and in, and in some cases may be seen through it. In favorable cases, the manubrium will spring outwards; the membrane become more mobile; tinnitus, vertigo and cerebral disturbance cease, and the hearing improve, especially after two or three inflations.

The after-treatment for all operations upon the membrane should be the warm douche to allay pain and wash out the blood, a tuft of cotton in the meatus, the administration of a few doses of Aconite, daily inflations with the air-bag, and, after inflammatory reaction subsides, energetic general treatment for the aural condition.

The restorative power of the membrana tympani is wonderful and the perforation generally closes soon, unless energetic efforts are made to keep it open.

I have attempted to cut the tensor tympani in seven patients. In two cases, I was obliged to desist because of the pain and rebellion of the sufferers. Three other patients derived no benefit from the operation, one having acute inflammation of the tympanum for some weeks afterwards. Two cases out of the seven were materially benefited. One was relieved of a distressing, hissing tinnitus, and occasional attacks of vertigo, whereby the hearing for the voice was somewhat improved; the other lost a loud pulsating tinnitus, which had often kept him awake at night, and gained considerable audition, after a few weeks treatment. I must confess, I felt serious misgivings at undertaking this operation, and I believe some of the above cases were not diagnosed

carefully enough from adhesive inflammation of the membrana tympani and ossicles.

I do not consider the operation so difficult for the well-trained aurist, who has a steady hand, and I do not have the discouraging idea of it, that Dr. Burnett does. I believe in the optimism of Roosa, who says: "It having been demonstrated that the operation is a safe one, and that it usually has a temporary beneficial effect, especially in diminishing the tinnitus aurium, and that it sometimes does substantial benefit, we may, I think, hope more from it in the future, when it will be undertaken at an earlier stage of the disease of the middle ear. If thus performed, and followed up by treatment of the middle ear through the Eustachian tube, I think we may hope for substantial results from it."*

MEDICINES should be given internally for the different varieties of chronic inflammation of the tube and tympanum, just as for disease elsewhere. I have indicated the peculiar characteristics of certain medicines, which render them useful in aural disease, and refer the reader for some points, to what I have written in other parts of the book upon materia medica and therapeutics.

The measures instituted according to the laws of physics and surgery are paramount, and the topical application of chemical and medicinal substances is a great necessity in treating disease of the ear; but one may, also, derive some good from internal medication.

It is necessary to differentiate the varieties of chronic inflammation of the tympanum and tube. The humid, the dryer, and the proliferative phases of the affection require different medicines.

Pulsatilla is a good medicine for mild, moist inflammation of the tube and tympanum, when it has not existed very long, and evidence of deep organic alteration in the mucous membrane is absent.

Pulsatilla is a sweet word, and its orthography almost conveys an idea of those yellow-haired, blue-eyed, pale-faced, submissive, sensitive, tearful, tender creatures so frequently seen in "our

* A Practical Treatise on the Diseases of the Ear, Including the Anatomy of the Organ. D. B. St. John Roosa, M.A., M.D., etc.; p. 339.

girls." The medicine acts best upon this type of individual, but I have found it valuable for aural affections in other temperaments.

It is suitable for itching and dryness of the external canal ; a moist, reddish or yellowish, soaked appearance of the drum-head ; transient or permanent fulness and uneasiness in the ear ; dulness of hearing, mucous râles during blowing the nose and artificial inflation, occasional darts of pain through the ear, inconstant ringing or rushing tinnitus, occasional attacks of vertigo, flabbiness and hypersecretion of the pharynx, and considerable bland mucous discharge.

Kali hydriod. is an efficient agent for cases characterized by inflammation, with a profuse sero-mucous discharge obstructing the tube and tympanum, and accumulating constantly in the pharynx. The ears feel stuffed, the hearing is blunted, and occasional pains and coarse tinnitus are present. The external canal is generally moist from hypersecretion of thin cerumen ; the membrana tympani is red, congested, and thickened ; inflation is accomplished with difficulty or not at all, owing to spongy swelling or commencing proliferative changes. If râles are heard, they are moist and bubbling ; the pharynx is very sensitive, and bleeds easily upon contact ; it often presents the symptoms of hypertrophic pharyngitis, and profuse coryzas occur frequently. These symptoms are most frequently encountered in persons of sanguineous temperament, with dissipated habits, syphilitic dyscrasia, and the rheumatic or gouty diathesis.

Steady administration of the medicine will improve the catarrhal condition, and arrest the proliferation, which left untreated produces irremediable and most distressing deafness. It should be used sparingly, when there is anæmia and weakness ; it is more adapted to robust and otherwise healthy persons.

Natrum arsenicosum is another remedy, whose pathogenesis points directly to profuse catarrh of the pharynx, tube and tympanum. It is particularly applicable, when the patient is subject to severe coryza and epidemic influenza, and a rheumatic or gouty diathesis predominates. There is great sensibility to cold and exposure to cool air or a draft ; contact with cold objects, and taking iced beverages or food will cause the nose to drip serum,

and violent sneezing to ensue. The membrana tympani is reddened; there is fulness, tinnitus, deafness, and slight pain; inflation is difficult, but noisy when it succeeds; the pharynx and nose are often congested or inflamed, and the disease is rather recent. The medicine ought to be given in water, but should not be continued very long for obvious reasons.

Mercurius corros. is one of the best medicines with which to begin the treatment of long-standing, profusely humid catarrhs, with succulent swelling of the mucous membranes. It should be administered in all cases which result from syphilis. The external canal is generally moist with excess of cerumen; the membrane is reddened and thickened, and moves very little when the pneumatic speculum is used; there is coarse tinnitus, dulness of hearing, and a stuffed numb feeling in the ear. Inflation does not make the usual subjective or objective symptoms, because the air cannot get into the tympanum.

The pharyngeal walls are red, tumid, and stiff, especially, about the orifice of the Eustachian tube; the tonsils are large and flabby; a nasty slimy expectoration is frequent; the throat is often sore at night, and there are spells of dull aching in the tympanum, especially, at night and in damp weather. Mercury is the remedy *par excellence* for sanguineous temperaments; for good constitutions with a plus of vitality; for coarse fibred and rough individuals, afflicted with chronic tympanic catarrh.

Rhus tox. is efficient in certain kinds of rheumatism, and is serviceable in chronic inflammation of the aural mucous tract, in persons of a rheumatic or gouty diathesis. The distinctive symptoms are: rheumatic pains and stiffness in the muscles and joints; the face is florid and disposed to erysipelas; the external auditory canal is reddened and scaly; the membrana tympani is yellowish-gray, thickened, distorted, and often adherent to the promontory.

There is considerable fulness, deafness, and loud tinnitus; the cerebral circulation is exaggerated above the normal, and vertigo common and sometimes alarming.

Inflation generally succeeds and causes loud râles; the pharynx is hypertrophic, and the secretion in the ear and throat is copious and rather thin. Along with these symptoms, there will generally be imperfect digestion, sluggish liver and kidneys, and a

copious deposit of uric acid and urates after the urine has cooled. Rhus cannot be relied upon to cure, only to improve, and other medicines must succeed it, as a rule.

Nux vomica has proved of decided value in some few cases in spirit-drinkers, with hypertrophic pharyngitis, severe humid inflammation, and distressing tinnitus, due probably to dilatation of the tympanic vessels from paresis of the vaso-motor nerves. They are characterized by gastric irritation, flushed face, and vertiginous attacks threatening apoplexy.

Kali bichrom. is suited to chronic catarrhs of less severity, when the secretion is thicker, the Eustachian tube patulous, and the pharynx gray, as in atrophic pharyngitis. The external canal is generally scaly and hyperæmic, and may contain a little moist cerumen; the membrane has a pink or yellowish-gray color; it shows dilated vessels along the manubrium, and is depressed, distorted or adherent. There is ringing, hissing or humming tinnitus; considerable impairment of audition, and occasional vertigo. Inflation will bulge the membrana tympani outwards, relieve the sense of fulness, and cause decided râles. There is not much secretion in the tube or tympanum, and it has more consistency and adhesiveness, than in cases requiring Kali hydriod. The mouth of the tube is more likely to be soft and relaxed, than tensely swollen; and this, with weakness of the palato-tubal muscles, may necessitate the use of the catheter for inflation. The nose and pharynx are nearly always diseased, when this medicine is indicated, and debility from malnutrition or, perhaps, a strumous cachexia will guide the physician to the remedy.

Hepar sulph. calc. has a curative influence upon this disease. The phlegmatic and sanguineous temperaments are most susceptible to its power, and it is especially valuable in struma. The symptoms which have led me to use it are few. The skin is thin and rough, and prone to eczematous and furuncular eruptions, particularly in the canal. There are tender spots upon the scalp; the ear is unusually sensitive to wind and cold; the canal is pink and scaly, and has an excess of cerumen; the skin is so thin that abrasions occur easily, and gentle manipulations cause considerable suffering. The patient dreads to have the auricles touched, and shrinks in fear when the speculum is introduced.

The membrana tympani is often scaly and dry ; it shows a few congested vessels, and is limited in mobility owing to depression or adhesion. There is generally a slight tinnitus, diminished hearing, and paroxysmal fulness and rattling in the tube during inflation, which is easily accomplished.

The tube and tympanum contain only a moderate quantity of mucus, which is of syrupy consistency, and not tenacious. The pharyngeal opening of the tube is generally of fair size, and unobstructed ; the pharyngeal mucous membrane is rough and moderately hyperæmic ; soreness of the throat, glandular swellings, and nasal catarrh are not uncommon symptoms demanding this remedy.

Calcareæ phos. is one of the best medicines for tubal and tympanic catarrhs in children and strumous youths. The picture of disease is a very common one, and can be readily recognized. The patient has a lymphatic constitution ; the skin and mucous membranes are thin, and prone to inflame from slight causes ; there is increased secretion from the nose, throat, and ceruminous glands ; the external canal is moist, often almost occluded by excess of soft, tawny cerumen ; the membrana tympani is either pink or dirty buff ; it is depressed, but is easily restored by inflation.

There is a stuffed feeling in the ears with considerable deafness, but rarely any tinnitus. Inflation is accomplished easily, and causes bubbling râles and immediate improvement in the hearing. The tonsils are enlarged and flabby, their crypts wide and deep, and the pharynx is in a state of granular or hypertrophic pharyngitis. I feel satisfied that the phosphorus of this compound exercises a powerful influence upon these cases, but whether by improving general nutrition or by specific action, I will not venture to say. The medicine must be given for a long time, during which local treatment of the throat and ear should be pursued, in order to insure the best results.

Ferrum iod. can hardly be dispensed with in strumous cases of catarrhal otitis, accompanied by anæmia, defective assimilation of food, and considerable feebleness. It enriches the blood, and, at the same time, aids in eliminating through its iodine, the morbid principles in the fluid and solid tissues of the body. Its aural

symptoms are vague, but are much the same as those of Calcareo phos., and it may supersede or follow the latter, whenever debility becomes prominent.

Arsenicum iod. has a decided influence over chronic inflammation of the pharynx, tube and tympanum, when there is not much secretion or swelling, but a rough, granular condition of the mucous membrane, tending to proliferative changes. There is debility, disordered digestion, unhealthy muddy color of the face, and scaly, rough skin. The external canal is always dry and scaly; the membrana tympani gray, anæmic, atrophic, depressed, and often adherent to the inner wall of the tympanum; inflation is easily accomplished, causing a rattling, rushing sound without true râles; the drum-head moves out freely or, perhaps, only bulges a little behind the manubrium.

There is deafness; ringing, hissing or pulsating tinnitus of most persistent quality; a clucking sound sometimes when swallowing, and sudden, often distressing attacks of vertigo. The tube may be enlarged from atrophic changes, or diminished by granulations, adventitious bands and adhesions.

The pharynx is rough and granular, patches of atrophy and thickening of the mucous membrane alternate, and dryness and soreness of the throat are frequently present.

In short, the symptoms are those so commonly encountered in chronic inflammation, that has advanced nearly or well into the proliferative state.

Potassium bromid. is another medicine of considerable efficacy in this same class of cases, and is one of the best remedies for aural vertigo that I have ever used. It relieves the peculiar strained feeling of the brain, the inability to perform mental labor, and the confusion of thought connected with some aural diseases.

Bromine, like tobacco and cinchona, has a specific action upon the third cervical sympathetic ganglia, which supply the vessels of a large area with vaso-motor nerves. In large doses, all three of these agents produce paresis and dilatation of vessels, with vertigo, tinnitus, nausea, palpitation, etc.

In small doses, they stimulate the ganglia, promote vascular tonicity, and relieve symptoms that depend upon loss of power.

Experience established this before provings furnished an explanation of the *modus operandi*.

Chronic aural disease, nervousness, irregular cerebral circulation, easily flushed face, and rheumatic or gouty manifestations should lead to a consideration of this medicine.

Cinchona is very beneficial in the disease considered, when the palato-tubal muscles are weak, especially, if the patient has been subjected to malarial influences. Quinine administered grossly for disease caused by malaria produces many an aural inflammation. No more beautiful example of the *similia* doctrine can be found in the practice of medicine, than the relief of sudden attacks of hyperæmia of the ear and tinnitus by *Cinchona*. The medicine may be used with advantage as an intercurrent remedy, during the treatment of proliferative and other cases, but cannot be expected to have the deep-acting powers of *Arsenicum iod.* and *Kali hydriod.*

Hydrobromic acid was introduced to the profession by Dr. Woakes, of London, as an efficient medicine for nausea, headache, vertigo, pulsating tinnitus, falling down, and other symptoms usually considered as Ménière's disease, as well as for deafness, supposed by him to depend upon paresis of the tensor tympani muscle.

He thinks that it increases the inhibitory action of the third cervical sympathetic ganglion, causes contraction of the blood-vessels to which its vaso-motor nerves are distributed, and thus relieves pulsating tinnitus, etc., by diminishing hyperæmia of the labyrinth and other parts. The Eustachian tube and tympanum must be restored to as near a normal state as possible, before one can expect the best effects of the medicine. It is recommended in doses of \mathfrak{xxv} , well diluted in water, and taken every four hours.

I wished to verify the action of the medicine, and took a few drops of the acid in water, at intervals during the day, until I had swallowed half a dram. The taste was strongly acid and unpleasant, and the effects disagreeable. I experienced dryness and puckering in the throat, followed later by a decided sense of constriction in the pharynx, neck, and chest. It seemed as if I was about to have asthma, yet, the breathing continued uninter-

rupted and rhythmical. My face and head were hot, my brain had a dull ache, and waves of heat occasionally rushed over my face and neck, but the skin did not show any increase in vascularity. There was a decided ringing, non-pulsating, bilateral tinnitus, and a slight vertigo, when I moved my head much up or down, came on in the latter part of the day. My stomach was somewhat irritated by the acid; the heart beats were accelerated and excited into palpitation, and my arms had a dragging heaviness and dull aching, which made it seem as if they were not part of the body.

I have felt these same symptoms frequently, when I have been tobacco poisoned by too many cigars, but at the time of testing the acid I had not used the Indian solace for several months.

The next day, some irritability of the stomach and heart, and heaviness of the arms remained, and, the third day after, the pathogenetic symptoms had all ceased.

It is evident from this rough proving, that Hydrobromic acid will become a valuable remedy when its power shall have been better defined.

I think the dose recommended by Dr. Woakes much too strong. I have employed the medicine diluted in water, in drop doses every three hours, and relieved tinnitus, nervousness, and cerebral strain quite promptly.

CHAPTER IX.

ELECTRICITY IN AURAL DISEASE.

ELECTRICITY has been mentioned already as a means of treatment of certain conditions connected with aural disease. Electric currents pass through the ear, stimulate the mucous membrane and nerves, and excite contraction in the tympanic muscles.

The therapeutic value of electrization in chronic inflammation of the Eustachian tube and tympanum is undoubted. Stimulation of the labyrinth and auditory nerve, also, results from electrization, but the extent and value of this is still *sub judice*.

Dynamic electricity, generated by the chemical action of certain fluids upon carbon and metal plates, is almost exclusively employed in medical practice.

A Constant battery is one in which fouling of the plates is reduced to a minimum, and thus their polarity and consequent power are maintained for some time unchanged.

An Inconstant battery is one in which the plates become coated and foul, by which their polarity and power are gradually reduced. This necessitates frequent cleaning and repairs.

A Constant Battery consists of:

1. A metal which is attacked, and at the expense of which the electricity is produced; this is generally amalgamated zinc, and the wire from it is the cathode, or negative pole, of the battery.

2. A fluid, which attacks the zinc, and is usually dilute sulphuric acid.

3. A porous diaphragm or jar containing the zinc and dilute acid.

4. A depolarizing fluid, usually a solution of sulphate of copper, in another vessel surrounding the porous jar.

5. A collector which is not attacked, such as carbon, copper or platinum, immersed in the depolarizing fluid, the wire from which is the anode, or positive pole, of the battery.

6. A vessel containing the depolarizing solution and the collector, with the porous jar and contents setting in its middle.

This whole combination is a battery, and is called a pair, or an element.

When several elements are combined they are, also, called a battery. When connected with a commutator, rheotome, helix, etc., the whole should be designated a Galvanic apparatus.

The Daniell battery has zinc and copper plates; the zinc is immersed in sulphuric acid, one part to ten or twelve of water, the copper in a saturated solution of sulphate of copper. This combination improved by Siemens and Halske is the best element for a stationary battery. Twenty united cells with covered wire electrodes will furnish a sufficiently powerful galvanic current for any aural practice.

This primary galvanic current can be interrupted and controlled in various ways. A regulator should be attached so that one or more cells can be employed according to circumstances.

A galvanometer for measuring the current is very useful. A rheostat for diminishing the quantity of the electric current; a rheotome to interrupt the current; a rheotrope to reverse the same, and a helix of several coils, are regarded as necessities.

The whole apparatus with other accessories is now put up in a walnut case in such beautiful style, that it is economy to purchase it.

An Inconstant Battery differs from the constant in having only one vessel and one fluid, in which the negative collector and positive plate or plates are suspended. The chemical solution attacks the positive plate and satisfies its own affinity by dissolving and combining with the metallic atoms. Power of excitation and conduction of electricity is lost, as molecules of salt form, until the exciting acid fluid becomes neutralized by the base and all action ceases. The negative collector becomes polarized by adhesion of hydrogen atoms to its surface, and thus its power is, also, greatly diminished. In fact, the plates become foul, the exciting fluid useless, and cleansing and re-supply of fluid are frequently necessary, in order to have a useful battery.

The battery is inconstant, because it gives electric currents varying much in quantity and intensity. Yet, it is employed in

Galvanic apparatus much oftener than the cumbersome constant battery, and recent improvements have reduced the inconstancy and trouble of taking care of the cells to a minimum.

The Grenet cell is the favorite one in use at the present time. It consists of carbon and zinc plates, suspended in a glass or hard rubber vessel, containing a solution of bichromate of potassium one part, sulphuric acid one part, and distilled water ten parts. Its electro-motive force is twice as great as that of the constant Siemens and Halske cell, and its primary and induced currents are intense.

FIG. 122.

PRIMARY CURRENT BATTERY.

Batteries of two, eight, sixteen or more of these cells, fitted into a walnut case, having an attachment to lower the cells and thus get the plates out of the fluid when not in use, and furnished with the essential apparatus already mentioned for applying the primary and induced currents, are now supplied at a reasonable price. They are found in many physicians' offices, while the constant battery is almost a rarity.

A Galvano-Faradic Apparatus consists of a battery of one or more cells, connected by its poles with lamina of different sized wires, which are coiled concentrically around a core or bundle of

soft iron wire placed longitudinally. This induction cylinder consists of two primary coils of No. 22, and two secondary coils of No. 32 wire. Around the cylinder thus made there is a hollow non-magnetic draw-tube called the graduator. At one end of the heliacal combination, a delicately balanced rheotome, or current breaker, which is moved by the fitful magnetized core, is placed in the circuit, and the helices are connected by wires with positive and negative poles. The primary Galvanic current from

FIG. 123.

GALVANO-FARADIC APPARATUS.

the battery passes to the inner helix, and excites, as the current is broken and closed, to-and-fro currents of electricity of increased intensity in the outer helix. This is conducted by wires to the proper poles under the name of the induced, secondary, or Faradic current.

When one possesses a large primary current battery, either constant or inconstant, one or two of its cells may be connected with an induction apparatus upon a stand or cabinet. Of course,

this could not be easily transported ; therefore, it is preferable to have one of the excellent instruments, manufactured by the Galvano-Faradic Company, which consists of two Grenet elements and accessories, arranged compactly in a moderate-sized, walnut box. The cells are clamped in position, have close-fitting, vulcanite covers, or hydrostats, to prevent the fluid spilling, and can be used singly or combined. By pulling up a jointed, brass stem to which the plates are fastened, and bending it over, the carbon and zincs are raised and kept out of the fluid, when not in use.

The moderate primary current from these elements can be utilized by connecting the electrodes directly with their binding posts. There is a hole upon the platform, however, for the rheotrope, which when in position gives an interrupted primary current. Another hole upon the platform for the rheotrope gives the induced interrupted current.

There is the usual rheotome for moderate or rapid interruptions. The intensity of the induced current can be augmented by pulling out the regulator.

The whole apparatus is inclosed in a box, having a lock, hooks and handle, and can be carried about without fatigue, or any danger of the cells slopping over.

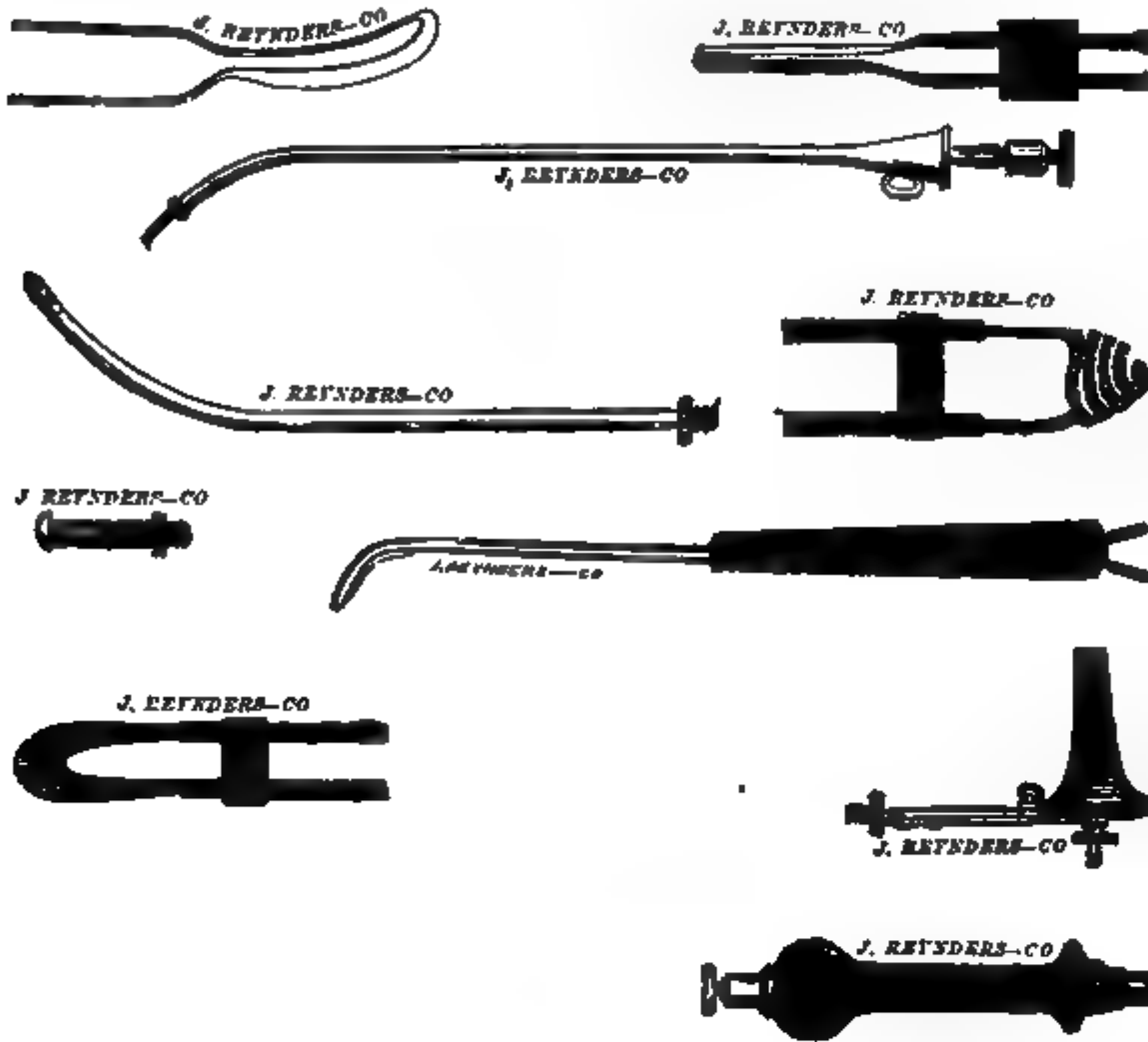
In my opinion, the primary current of this machine is about as strong as a physician should venture to use about the ears and head, unless he has made a careful study of electricity, and had considerable practical experience with batteries and their appurtenances.

The secondary, or induced current, ranges from gentle impulses to violent and unbearable shocks, according to the position of the regulator, and whether one or more cells are used. Though this current is not entirely devoid of danger, the irritation of the sensory nerves caused by it is greater than by the primary current, and furnishes a sort of warning against excessive use.

Dr. Butler says, "No one should think of using electricity, in any form, on the ear, without the use of a rheostat," but I think this assertion is rather too sweeping. It is certainly necessary to use the mildest currents at first, and to increase the strength cautiously, while paying the closest attention to the manipulation and the patient's symptoms.

Electrodes of several kinds are necessary in aural practice. One should have the ordinary insulated, silk-wound wires with handles furnished with moist batteries; a medium-sized sponge with handle; long, slender, knobbed instruments for the palato-tubal muscles and the external meatus; a silver or copper wire with smooth end for insertion through a hard rubber Eustachian

FIG. 124.



VARIOUS ELECTRODES.

catheter into the tube, and a small sponge or a rod electrode, insulated by a hard rubber tube or speculum, for insertion into the external auditory canal.

Care of apparatus is essential, if one expects it to do its work well. Every few weeks it will be necessary to remove the plates; scrape and then wash them clean with warm water containing a little sulphuric acid; reamalgamate the zincs by rubbing them

hard all over with quicksilver; clean and burnish all the connections with fine sandpaper and pumice-stone; empty and clean the cells when they need it, and put in fresh fluid.

Above all, never leave the circuit closed, and always have the plates out of the fluid when they are not in use.

FIG. 125.

CAUTERY BATTERY.

QUALITIES OF THE CURRENTS.—The Galvanic primary and the Faradic induced currents differ considerably in their properties. The advantages of the Galvanic over the Faradic current are:

1. It has greater power of overcoming resistance, by which it penetrates deeper, and permeates the tissues more thoroughly. This renders it more potent in diseases of the labyrinth or auditory nerve.

2. It has power to produce muscular contractions in some cases where the Faradic has no effect. In such cases, after treatment awhile with the Galvanic, the Faradic acts better.

3. It possesses a much more potent catalytic, chemical, and electrotonic action, and its effects last much longer. These qualities make it more suitable when the tissues of the middle ear and Eustachian tube are much affected, and a profound influence upon the nutrition is desired.

The advantages of the Faradic over the Galvanic current are :

1. By its interruptions, it produces many thousand muscular contractions in a few minutes, and greatly stimulates the nutrition of the muscles. It is, therefore, well adapted to paresis of the palato-tubal and tympanic muscles.

2. It produces greater mechanical effects upon fibrous and muscular tissues, and is, therefore, preferable in stiffness or ankylosis of the ossicles.

3. It is less likely to produce unpleasant or harmful effects when incautiously used, than the Galvanic.

4. It does not spread about much and causes less reflex action. It rarely induces phosphenes when applied to the ears, as the Galvanic current does.

THE POLES differ in electrical effects upon animal tissues. Small electrodes when applied to the body cause more pain than large ones, and metallic, than those covered with wet flannel or sponge.

The positive pole and descending current are regarded as calming and soothing, and the negative pole as more irritating. When their positions are reversed, opposite effects are produced. The positive irritates and stimulates vital energy, and the negative quiets and soothes.

The positive pole has a stronger effect upon a healthy muscle when opening the circuit, the negative when closing it.

These effects are contrary when the muscle is diseased. The effect of the positive pole upon paralyzed muscles increases faster than that of the negative ; the latter, however, has more effect upon the sensory and motor nerves, and causes a stronger sensation. The negative pole of the primary current can be differentiated from the positive by its producing a burning sensation.

In muscular spasms and neuralgia, the positive pole should be central and the negative peripheral.

In anæsthesia and motor paralysis, the negative pole should be central and the positive peripheral.

It is recommended to apply the positive pole to sthenic inflammation, and the negative to asthenic.

These must be considered general statements, to which there are numerous exceptions. Experience must be the guide. Cases are cured sometimes when the poles are applied one way, sometimes when another. Dr. Butler and some other electricians believe it makes very little difference which way the current runs.

METHOD OF APPLICATION.—There are two ways of applying electricity to the ear, called the internal and external.

In the internal method, a silver wire electrode insulated by a hard rubber catheter is introduced well into the Eustachian tube. A knobbed electrode, covered with flannel and moistened with water, or a wet sponge electrode is pressed firmly against the tragus, so that the external meatus is closed, and the circuit is completed. Either of these electrodes may be insulated by a rubber tube or speculum and introduced into the auditory canal, which has been previously filled with warm water containing ten per cent. of common salt. The negative pole should be connected with the electrode in the Eustachian tube, when it is desired to stimulate muscular action and nutrition, and to loosen adhesions and ankylosis of the ossicles. The positive pole should replace it, when a more profound and lasting effect upon the mucous membrane and stimulation of the auditory nerve are required, as in case of deep inflammation and tinnitus.

In the external method, a knobbed or a small sponge electrode is placed in the flooded auditory canal or upon the tragus, as in the internal method. A large wet sponge electrode is pressed upon the superior cervical sympathetic ganglion just behind the angle of the jaw, upon the nape of the neck beyond the middle line, upon the tragus or in the meatus of the opposite ear, and the circuit is made. Some authors recommend that the second electrode be held in the hand of the side opposite the ear which is being electrized.

The position upon the ganglion or the nape of the neck is the best for the second pole, and currents of moderate intensity pass without distress or danger. The external method is employed mostly with the Galvanic current and rheostat, in order to determine the condition of the auditory nerve, and to arouse its vital energy.

The negative pole should be proximal, *i. e.*, upon the tragus

or in the meatus, because it produces greater excitation of the auditory nerve than the positive does.

SYMPTOMS OF AURAL ELECTRIZATION.—The symptoms produced by electric currents upon the ear vary somewhat with the quality, intensity, method of application, etc., but are sufficiently common to be grouped together. When the poles are applied by either method, shock and pressure are felt in the ears, and one hears a sound of scratching, buzzing, bubbling, whistling, hissing, ringing, singing, humming or rumbling, according to the circumstances and conditions present. The sensation may run through this gamut of sounds, though it is usual for it to be limited to one or two. Any of these sounds may prevail, increase with the intensity of the current and under the influence of the negative pole, and decrease with the intensity and under the influence of the positive pole. The sound in a healthy ear is often a clear musical tone, which some authors think corresponds to *a* or to *g*. Other effects produced are: sensations of heat, pricking, and pain, especially at the negative electrode; vertigo, and flashes of light before the eyes; contraction of the facial muscles; perspiration upon the forehead; sometimes constriction of the throat, and nausea; metallic taste in the mouth, and excessive flow of saliva, owing to irritation of the chorda tympani nerve. There is at first paleness, then hyperæsthesia and congestion of the tympanum, increased secretion of cerumen, stimulation of the tympanic mucous membrane, and excitation of the muscles, with consequent movement of the ossicles and vibratory impulses of the labyrinthine fluid, which call forth the vital energy of the auditory nerve.

Dr. Brenner, of St. Petersburg, Russia, has studied the reactions of the auditory nerve to the electric current, and arrived at a formula to represent them. He believes the nerve responds regularly to the Galvanic current by distinct sounds at and during the closing of the negative pole, and at the opening of the positive, and thinks the formula is changed by disease.

An average normal formula is as follows:

1. Ka. S. Kl'.—Kathode, Schliessung, Klingen laut.
2. Ka. D. Kl. >.—Kathode, Dauer, Klingen.
3. Ka. O.—Kathode, Oeffnung.
4. An. S.—Anode, Schliessung.
5. An. D.—Anode, Dauer.
6. An. O. Kl. >.—Anode, Oeffnung, Klingen.

Translated :

1. Ca. Cl. R'.—Cathode, closing, ringing loud.
2. Ca. D. R. >.—Cathode, duration, ringing.
3. Ca. O.—Cathode, opening.
4. An. Cl.—Anode, closing.
5. An. D.—Anode, duration.
6. An. O. R. >.—Anode, opening, ringing.

This requires further explanation in order to be understood by the uninitiated.

1. When the cathode is at the ear, the anode being some distance away from it beyond the middle line of the body, and the current closed, the subject hears a loud noise, generally a ringing sound.

2. In the duration of this current, the ringing gradually diminishes and finally ceases altogether.

3. When this circuit is broken by removing the cathode, no sound is caused.

4. When the current is reversed, and the circuit is closed by applying the anode to the ear, no sound is produced. When the electricity is of high intensity, a slight ringing may be experienced.

5. In the duration of this current, no sound is heard.

6. When this circuit is broken by removing the anode, a slight and transient ringing is experienced, corresponding to that of No. 2. It is well to remember that the ringing may be replaced by the various sounds already mentioned, so that the term noise would express the reaction more accurately for all cases.

The reactions are modified by the experiment alone.

Ka. S. is stronger after An. S., and continued some time increases the reaction of the nerve. An. O. ringing increases with the intensity of the current and its longer duration.

Dr. Butler says, "This formula is nothing more than the Galvanic reaction upon healthy auditory nerves. Why its correctness should ever be questioned by any one who has thoroughly and honestly tested it, I am at a loss to discern."

It is evident the Galvanic current furnishes another means of diagnosing disease of the ear. Any alteration in the formula signifies a morbid condition of the auditory apparatus. The Galvanic reaction serves to confirm aural disease, which is ap-

parent by other methods of examination, but it is especially valuable in diagnosis of morbid conditions of the labyrinth, auditory nerve, and brain.

It is curious that in some cases, when the cathode is applied to one ear and the formula is tested, the other ear responds by sensations at the time when the first ear gives no reaction, just as if it were under the influence of the anode. This second series is called an inverted, or paradoxical formula. I present an example given by Brenner. Nine cells were used :

Right Ear Healthy, with Cathode.

Ka. S. Kl'.—Loud ringing.

Ka. D. Kl. >.—Ringing gradually
ceasing.

Ka. O.—No sound.

An. S.—No sound.

An. D.—No sound.

An. O. Kl.—Slight ringing.

Left Ear Diseased.

Ka. S.—No sound.

Ka. D.—No sound.

Ka. O. Kl.—Ringing.

An. S. Kl'.—Loud ringing.

An. D. Kl. >.—Ringing gradually
ceasing.

An. O.—No sound.

This inversion is frequently presented, when there is hyperæsthesia of the nerve submitted to the cathode, with exaggeration of its normal reactions.

A case of chronic inflammation of the tympanum with deafness and much tinnitus, subjected to twenty cells, gave the following :

Ka. S. Kl'.—Loud ringing.

Ka. D. Kl. ∞ .—Ringing *continuous*.

Ka. O.—No sound.

An. S.—No sound.

An. D.—No sound.

An. O. Kl. >.—Ringing gradually diminishing.

A similar case tested with ten cells gave :

Ka. S. Kl'.—Loud ringing.

Ka. D. Kl. ∞ .—Ringing *continuous*.

Ka. O.—*Rattling*.

An. S.—*Rattling*.

An. D.—*Rattling continuous*.

An. O. Kl. >.—Ringing gradually ceasing.

Another case with chronic inflammation of the tympana, opacity of the membranes, and deafness of many years duration, under twenty cells gave :

Ka. S.—Chirping.

Ka. D.—Short chirping.

Ka. O.—No sound (*slight and short roaring in left ear*).

An. S.—*Roaring*.

An. D.—*Short roaring*.

An. O.—*Indefinite sounds*.

Beard and Rockwell report testing an ear, that had been cured of perforation of the membrana tympani and purulent inflammation of the middle ear, with restoration of normal hearing. The patient was a young man, and eight cells were employed.

Ka. S.—Some rumbling.

Ka. D.—Some rumbling.

Ka. O.—No sensation.

An. S.—*Rumbling*.

An. D.—*Rumbling*.

An. O.—No sensation.

This reaction proves that the ear was not fully restored.

In these examples, the deviations from the normal formula have been mostly printed in italics.

Brenner and others consider the Faradic current useless for these tests, and recommend the Galvanic current of two to twenty cells. The rheostat is necessary, if a current of high intensity is employed, and the external method of applying the electrodes is preferable.

Notwithstanding the apparent simplicity of Brenner's method of diagnosis, its practice is beset with many difficulties. Success will attend only the most careful and scientific manipulators and the coolest and closest observers.

Whether the electric current acts upon the auditory nerve through reflection from the trifacial, through the tympanic muscles or by direct, deep passage of the electricity, I shall not stop to discuss. Probably the nerve is influenced in all these ways, but the last is the most potent in awakening sensations.

ELECTRICITY IN DISEASE.—There is considerable difference of opinion among aural surgeons in regard to the value of electricity in diseases of the ear.

French and German physicians look upon it as almost indispensable, but I heard a German, even, in one of the most celebrated aural clinics in the world, say, "*Eine Galvanische Batterie ist ein schönes Spielzeug für Kinder.*" English and American

doctors employ it sparingly, and many of them speak about it contemptuously.

The differences are individual rather than national, and the use of the powerful agent is restricted, because medical men have been deterred from a careful study of electrical apparatus and electro-therapeutics by imaginary difficulties and dangers, and by their disgust at the charlatanism displayed by peripatetic quacks and impostors.

One has only to compare electricity with other forces to appreciate its extraordinary power. An electric discharge that endures but the millionth of a second is sufficiently powerful to split the proudest tree of the forest into splinters, and to shatter and destroy the largest edifice of man. Nerve currents that seem to us almost instantaneous, move at a speed of 26 to 30 meters, and light travels at the rate of about 300,000,000 meters in a second, but electricity has the wonderful velocity of 464,000,000 meters in the same space of time.

This intangible manifestation of force, that enables us to talk with people at the antipodes, is too valuable to be relegated to the ignorant and dishonest. It must be appropriated by all scientific physicians, and become a valuable addition to the *armamentarium medicorum*.

The use of electricity in aural disease has been too limited, and it will ever remain so, unless we all take hold of our batteries and work and write it into deserved prominence.

Electricity is of considerable value in idiopathic otalgia, tinnitus, paralysis of the facial and chorda tympani nerves; hyperæsthesia, torpor or paralysis of the auditory nerve; labyrinthine disease, with partial or total deafness; chronic inflammation of the tympanum, with adventitious bands, and ankylosis of the ossicles; and in spastic contraction and paresis or paralysis of the tympanic and palato-tubal muscles.

Otalgia, when not relieved by the usual measures, is sometimes promptly cured by the continuous Galvanic current applied by the external method, the anode being in the auditory meatus.

Tinnitus may be treated by the same current, with the anode in the Eustachian tube, and the cathode in the meatus, upon the mastoid, or over the superior cervical sympathetic ganglion.

Paralysis of the facial nerve and chorda require the Galvanic current, with the electrodes applied nearly in the course of the main trunk. The anode may be placed over the stylo-mastoid foramen or in the auditory meatus, and the cathode in front of the masseter muscle. The current may be reversed occasionally.

Hyperæsthesia, torpor, and paralysis of the auditory nerve are best treated by the Galvanic current, with the cathode in the meatus, and the anode upon some part of the other side of the body.

Labyrinthine disease with deafness should be subjected to the same treatment. The so-called nervous deafness belongs under torpor of the auditory nerve, though generally there is more or less disease of the tympanum.

Chronic inflammation of the tympanum with attendant changes may be experimented upon with both the Galvanic and Faradic currents. The anode should be in the Eustachian tube, and the cathode in the meatus or upon the mastoid process. The current may frequently be reversed to advantage.

Contraction, paresis, and paralysis of muscles demand the Faradic current, with the cathode upon the velum or in the Eustachian tube, and the anode in the meatus. If symptoms are not ameliorated, the current should be reversed, and in obstinate cases the Galvanic current tried.

Dr. Houghton, of New York city, reports a case of paresis cured by the Galvanic current. The anode was placed in front of the auricle and the cathode behind the angle of the lower jaw.

These directions will serve to guide the novice somewhat in his use of electricity in aural diseases. If no improvement follow a given method of application, it would be advisable to reverse the current by turning the rheotrope, and should one kind of electricity prove useless, the other ought to be tried before abandoning an agent that has proved so potent for good in the hands of trustworthy and able physicians.

The reader can follow up this subject with pleasure and profit in *A Text Book of Electro-Therapeutics and Electro-Surgery*, by John Butler, M.D., L.R.C.P.E., etc.; and in *A Practical Treatise on the Medical and Surgical Uses of Electricity*, by Drs. Beard and Rockwell.

CHAPTER X.

THE INTERNAL EAR.

THE Internal Ear is more delicate and complex than any other portion of the auditory apparatus, and almost inappreciable pathological changes in its soft tissues are sufficient to diminish or destroy audition, and to cause decided constitutional disturbances. There is no doubt that the labyrinth has its own primary diseases, but a larger proportion are secondary to affections of contiguous tissues in the tympanum and the cranial cavity.

The labyrinth is situated so secluded from sight and touch, that it is difficult and in some cases impossible to arrive at an accurate diagnosis of its morbid conditions. In consequence of this, some writers upon aural diseases either pass over this division of the subject hastily and discredibly, or mix their descriptions, to the confusion of the student, and the demoralization of classification.

It is important to rescue this department of otiatrics from neglect and confusion, and, by avoiding profuse speculative theories, to make scientific facts more prominent.

Allusions to labyrinthine and intracranial affections have been made frequently in connection with diseases of other parts of the ear in previous chapters. It will be necessary for the reader to refer to these for information upon the slight disorders of function of the auditory nerve and brain, often sympathetic and transient, and for fracture, hyperostosis, and caries of the temporal bone.

Diseases of the internal ear are rare, relative to those of the middle and external ear, and one may practice many years and only see a few cases. The observer must be well read in general medicine, particularly in nervous diseases, in order to appreciate the significance of symptoms belonging in common to the auditory nerve and brain.

Diseases of the internal ear I have classified as follows: Anæ-

mia, Hyperæmia, and Inflammation, including nervous deafness, Ménière's disease, and paralysis from concussion.

Anæmia.—This condition of the labyrinth may exist alone or be associated with the same disorder in the brain and general system. There is a deficient supply of blood to the internal ear, or the blood is deficient in red corpuscles and other nutritive elements. This latter state would be better expressed as hydræmia, but this word has not been permitted to replace the former term, which holds right of possession in all our medical works, and still conveys an exact meaning.

Anæmia of the labyrinth has a variety of causes. It may be a consequence of pressure upon the fluid contents by depression or thickening of the membranes of the round and oval windows from tympanic disease; of narrowing of the auditory artery by endarteritis, pressure from hyperostosis of the temporal bone, or intracranial tumors; of occlusion of the artery by an embolus; of aneurism of the basilar or carotid artery; of reflex action through the sympathetic, or vaso-motor nerves, from disease of the spinal cord and other organs; or of general anæmia and debility, arising from mental exertion, anxiety, hemorrhage, and severe constitutional disease.

Some of these causes will ultimately induce more serious disorders in the ear than simple anæmia, which is either temporary or antecedent to other morbid states.

A symptom of anæmia of the labyrinth is tinnitus like the sighing of wind through the trees, the distant roar of the ocean, the murmurs of a conch shell, and sometimes like sharper and rougher sounds.

The sounds are generally low and continuous, but may be augmented with every heart-throb by sounds of arterial pulsation. In general anæmia, the well-known bruit of the jugulars causes a characteristic humming tinnitus when there is disease of the tympanum, but the tinnitus of labyrinthine anæmia is different. Those who become insensible from syncope, suffocation, and anæsthesia experience and can describe it. In such cases, it is loud and tumultuous; in anæmia of the ear *per se*, it is softer and less constant.

Another aural symptom is temporary or permanent impair-

ment of hearing. The auditory nerve is not adequately nourished and its sensibility is diminished ; the subjective noises overpower vibrations transmitted from without, and the patient cannot hear well. The degree of impairment of audition depends upon the cause of the anæmia ; if the deafness is great and the tympanum healthy, there is serious general debility or some grave local lesion existing.

Vertigo accompanies most cases. It comes and goes with sudden movements of the body, and, also, when quiet is maintained. It does not cause turning or falling impulses, but a swaying and hovering sensation, as if the head were too light, and went sideways now and then.

Vertigo, tinnitus, and deafness are common symptoms in aural disease, and their existence is not presumptive evidence of anæmia. The diagnosis of the condition must be made by exclusion, and a careful estimate of all the subjective symptoms ; the objective cannot aid it much. The history of the case ; habits of the patient ; healthy condition of the tympanum, external canal and Eustachian tube ; the character of the tinnitus and vertigo ; the impairment of hearing ; the defective reaction to the tuning-fork, and modifications of Brenner's formula will enable one to make a proper diagnosis. Other symptoms and examinations will be necessary in suspected cerebral disease, particularly an inspection of the optic nerve.

Schwartz says : ' The anatomical recognition of anæmia of the labyrinth is very difficult ; it is still doubtful whether these aural symptoms cannot be referred with equal justice to changes in the intracranial circulation, and a consequent imperfect perceptive power in the central organ, the brain. '*

Treatment.—The patient's physical and mental state should be fully investigated ; his health improved by every means possible ; the mind relieved of strain or anxiety, and intellectual work diminished and regulated.

The existence of disorder or disease in any part of the body, especially in the brain, should be treated *secundum artem*, and such medicines administered as the totality of symptoms may indicate.

* The Pathological Anatomy of the Ear. Schwartz, p. 156.

Ferrum will prove efficacious in general anæmia and chlorosis; Arsenicum when there is a dartrous diathesis, accompanied by much irritation and debility; Calcareæ phos. for strumous and delicate constitutions; Mercurius and Kali hydriod. for syphilis; and Cinchona in malarial cachexia, and great debility following hemorrhage and constitutional diseases.

Inflation ought to be performed occasionally, and every two or three days a little vapor of sulphuric ether sent through a catheter into the tympanum to stimulate the local circulation. The hot aural douche may be employed a few times, and benefit may be derived in some cases from keeping the patient at rest in a recumbent position.

The Galvanic continuous current ought to be used daily for five minutes, placing the cathode in the meatus and the anode upon the other side of the neck or in the opposite ear.

The current must be very weak at first, and then gradually increased as the patient can bear it. It is safest in such cases to use a rheostat in the circuit.

I have had two cases of anæmia of the labyrinth in which the diagnosis could not be questioned, though probably in both there was coexisting anæmia of the brain.

CASE I.—A lady, who had a good constitution and excellent health, and was on the shady side of sixty years, went through a severe attack of diphtheria, and suffered during several months following from the consequent debility.

The patient came to me for peculiar sensations in her ears. She said when she went about and went up and down stairs, she frequently experienced a sensation as if something fell in her ears, then a distressing roaring would intervene, and a slight degree of vertigo ensue. The first attack startled her so that she threw herself forwards upon a sofa, and the symptoms immediately ceased. She said she did not feel faint or nauseated, and did not lose consciousness in the least. The experience gained the first time enabled her to conquer subsequent attacks. Whenever the same symptoms returned, she would bend herself forwards until the trunk was horizontal and relief would immediately follow.

The patient said she felt tolerably strong and went about, not-

withstanding the unpleasant consequences, and so she was very frequently making profound salaams to the furniture and people at unexpected moments. The nose, pharynx, and Eustachian tubes were healthy; inflation of both tympana was easy; the external canals and membranes were a little dry, and the tympana seemed only affected by the desiccation and contractions of senility.

The fork was heard equally well by both ears *per ossam*, and Hw. $\frac{3}{8}$ upon either side.

Her health seemed good, but there were some symptoms of dyspepsia, and the circulation was feeble.

I blew ether into the tympana, applied diluted glycerine to the drum-heads, and gave Nux vom. to be taken before, and a powder of Quinia sulphate after meals. Improvement was rapid, and the aural sensations ceased within two weeks.

CASE II.—A man, about fifty years old, of fair development, and good constitution, had a severe attack of typhoid fever, accompanied by much deafness of the labyrinthine variety. There was roaring in the ears, but there had been no acute affection of the tympanic structures as far as known. Convalescence from the fever was slow, and the patient was confined to his room in bed most of the time for four weeks after the disease had run a typical course.

Tinnitus had then ceased in the right ear, but persisted in the left, whenever he took a vertical position. This would come on as soon as he sat up in bed, or got out in his easy chair. It was of the character of a steady roaring, which he compared to that produced by wagons rolling over a paved street. There was a very little vertigo, but he complained of the noises as very distressing.

The patient was anæmic and feeble; his pulse was thready and weak, and his appetite poor. Both ears presented the typical symptoms of chronic inflammation of the tympanum. The drum-heads were yellowish-gray, thickened, and opaque; the malleus handles were slightly drawn inwards; the pharynx was tolerably healthy; the tubes opened well to inflation, which moved the drum-heads out moderately. The right ear had

Hw. $\frac{1}{2}$; the fork upon the vertex was heard by both ears, but better upon the right side.

I prescribed Cinchona tincture, ten drops in water four times a day. There was very little change in the condition after a week's treatments, and I then ordered Quinia sulphate $\frac{1}{4}$ gr. four times a day. In one week, the aural symptoms had ceased, and the patient was discharged.

Hyperæmia.—This condition of the internal ear frequently coexists with tympanic disease, and with disorders of circulation in the cerebrum. The amount of blood in the labyrinth is increased beyond the normal; the blood may be in active circulation, coming in and passing out rapidly, or the currents may move slowly, leaving stagnant foci here and there. Both conditions may produce pressure upon the filaments of the auditory nerve, and thus give rise to nearly similar symptoms.

The congestion supervenes frequently from slight causes, and passes away without doing more damage, than temporarily altering the functions of the apparatus. Again, it remains constant, induces slow or rapid pathological changes in the membranous labyrinth, and causes partial or total deafness. It is the condition antecedent to the grave affections of the internal ear, which occur as a consequence of certain constitutional diseases, and should always be regarded with suspicion.

Labyrinthine congestion of a mild grade is produced by both acute and chronic disease of the tympanum.

Anastomosis of the vessels of the mucous membrane of the middle and internal ear has been demonstrated by the researches of Politzer. Anything that causes hyperæmia of the middle ear, such as impacted cerumen, furuncles of the canal, injuries of the drum-head, sore throat, obstruction of the Eustachian tube, etc., will induce corresponding congestion in the deeper structures. On the other hand, hyperæmia of the brain from mental states, hysteria, general debility, mental worry and exhaustion, indulgence in alcoholic beverages, large doses of quinine, and some other medicines, cause congestion in the labyrinth very soon, because of the direct and copious supply of blood to the parts through the internal auditory artery.

Graver degrees of labyrinthine congestion, those which often

lead to profound organic change, occur from disease of the temporal bone, fracture of the skull, meningitis, apoplexia, cerebral abscess, tumors, aneurisms, obstruction of the venous circulation, heart disease, poisoning by carbolic acid, and various constitutional diseases.

The symptoms of uncomplicated and moderate hyperæmia of the labyrinth are, at first, exaltation of hearing, a sort of hyperæsthesia of the nerve, and sounds of moderate intensity cause discomfort and annoyance to the patient, especially when he is in a quiet place or if he tries to go to sleep. A fine ringing tinnitus usually accompanies this state, and vertigo is not very uncommon. The mild cases if continuous soon merge into severe ones.

When the labyrinth becomes much congested, the auditory power declines rapidly, ranging from an inability to hear medium voice to total deafness. The tinnitus then becomes louder; coarser and rougher sounds of hissing, rumbling, cracking, etc., are experienced; transient spells of vertigo occur, sometimes becoming so severe as to cause falling, and the patient feels insecure and alarmed.

The symptoms are all aggravated by mental excitement and anxiety, by voluntary exercise of the auditory power, and by general systemic fatigue and debility.

Toynbee relates a typical case. "I had for a long while a patient under my care, who, when perfectly tranquil, could distinctly hear his daughter reading to him, at about the distance of a yard; but if his daughter told him anything which excited his interest, he became so thoroughly deaf as not to be able to hear a sound, and would remain so until the excitement vanished, when his hearing would return."

I had a young lady under treatment for a mild tinnitus, with unobstructed tubes, and nearly normal tympana. She was inclined to plethora, and had considerable cerebral congestion and nervous disturbance during menstruation. The deafness varied from low to loud voice. In spite of treatment, she grew worse. I found that she was taking a glass of ale at lunch every day. I stopped this, her head became clear, vertigo and tinnitus ceased, the hearing improved much, and remained good.

Hyperæmia can be recognized by its history, subjective symp-

toms, and response to certain tests. The Galvanic current will give an abnormal formula; the fork in most cases will not be heard clearly, and the other parts of the ear will show conditions not potent to cause such great impairment of auditory power.

Treatment.—The cause of the hyperæmia should first receive attention, and when this consists of morbid conditions of the middle or external ear, of the brain or interior structures, they should be removed if possible by treatment of the ear, and by the administration of general constitutional remedies, according to the principles already given, and others belonging to general medical art.

The general health and strength should be raised to the highest degree by careful regulation of the physical and mental labor, diet, exercise, recreation, and personal habits.

Of the medicines appropriate for ordinary cases, Belladonna is very efficient. It diminishes the hyperæmia of the labyrinth and brain often in a surprisingly short space of time. Cinchona has a specific action upon the auditory apparatus, and is suitable for patients of nervous temperament, who have been subjected to mental strain and worry, and, perhaps, exposure to a malarial atmosphere.

Kali bromidum relieves congestion, dulness of hearing, tinnitus, and the uncomfortable, strained, confused feeling of the head very promptly.

Nux vomica suits passive congestion in spirit-drinkers. It stimulates the vaso-motor nerves, causes contraction of the blood-vessels, and thus relieves the labyrinthine disorder.

Salicylic acid has been recommended in tinnitus dependent upon hyperæmia, and has proved curative in some cases.

Conium and Pulsatilla are excellent medicines for a female patient with hyperæmia depending upon menstrual disturbance. Bryonia and Colchicum may prove valuable, when the affection is connected with rheumatic or gouty manifestations.

Kali hydriod. ought to be given, when the history or symptoms point to a possible syphilitic lesion.

The Galvanic current may be tried as a last resort, when other measures are unsuccessful, provided there are no cerebral or other contraindications. The anode should be placed in the auditory canal and only a weak current employed.

Inflammation of the Labyrinth.—Tissues cannot remain long in a state of vascular turgescence without undergoing alteration and proliferation, and the delicate structures of the labyrinth are no exception to the rule. The slightest causes change normal cells into pathological ones, and inaugurate processes which unchecked go on to pervert function and destroy structure. Inflammation is excited in the labyrinth by its local nutritional changes, and by morbid influences transmitted from other parts of the ear and from within the brain case, and once well started in this confined space, its results are most disastrous to audition. Congestion, effusion of serum, exudation of plastic lymph, ecchymosis and hemorrhage, proliferation, fatty degeneration, and formation of pus occur here, as elsewhere, and lead to unique local and general symptoms.

A study of the scanty literature upon labyrinthine disease will produce the conviction, that the relation between cause and effect cannot be so clearly defined, as in morbid processes in other parts of the body.

The causes of inflammation in the labyrinth are multiple, the effects are not constant for the same cause, nor can they be determined with certainty in any case without a post-mortem examination of the temporal bone and brain.

Disease of the tympanum, excessive use of quinine, exposure to severe cold, concussions and falls; caries, fracture, rheumatic periostitis, calcareous degeneration of vessels, the concretions of gout, and syphilitic deposits; obstruction of the circulation from aneurism, embolus, tumors, and heart disease; apoplectic attacks; the shocks of parturition; acute tuberculosis, mumps, diphtheria, erysipelas, measles, scarlatina, variola, typhus and typhoid fever; hydrocephalus, convulsions, meningitis, and cerebro-spinal meningitis are all enumerated as causes of internal ear disease.

One group of causes generally induces congestion and subacute inflammation in the labyrinth, which creeps on slowly and insidiously, and gradually diminishes the hearing. The so-called nervous deafness from rheumatic periostitis, gouty concretions, atheromatous vessels, continuous avocation-noises, large doses of quinine, intemperate use of alcoholic beverages, syphilitic deposits, aneurisms, tumors, heart disease, repeated shocks from

parturition, and, probably, some of the fevers, is often dependent upon subacute inflammation in one or all parts of the labyrinth.

There is at first increased sensibility of the nerve to sounds; the hearing seems very acute, so that the patient is annoyed at some tones, but the ability to hear the voice, watch and fork is really below the standard. There is tinnitus of a mild ringing, singing, hissing or rushing character at the beginning of the disorder, accompanied by slight attacks of vertigo, and an empty feeling in the head. As the disease advances, the hearing gradually declines; the voice and watch are no longer perceived; the fork upon the vertex is barely distinguished as a muffled tone, and the facial nerve gradually alters the tonus of the muscles of the face, so that it presents that wistful look so apparent in deaf persons. The symptoms will vary somewhat with the stage of the disease, the degree of moisture, the electrical state of the atmosphere, the amount of blood in the head, and the health of the patient. Before and during storms the hearing power will be depressed or lost. Hyperæmia of the brain will aggravate the aural disease and diminish audition, while an anæmic state of the cerebral circulation will improve it temporarily. Vertiginous attacks belong to the morbid condition of the labyrinth, but they are rendered severe and more frequent by gastric disorders. A person without any aural disease, or with one of mild degree, is liable to have sudden and transient attacks of loud tinnitus and severe vertigo, owing to reflex action from the stomach through the sympathetic nerves.

Subacute inflammation in some cases, after doing a certain amount of damage to the labyrinth, becomes arrested by removal of the cause, by exhaustion of its irritation, or by the supervention of senile atrophy. I know no other explanation for conditions that one meets so frequently in practice, where the tympanum is but little if any affected, and the fork is heard very faintly, yet, the patient affirms that there has been no increase in the deafness for years.

A woman, twenty-five years of age, enjoying good general health, was deaf to loud shouts, but heard faintly the sound of a large tuning-fork. She said she had had noises in her ears and

began to lose her hearing, during a severe attack of measles, twelve years before. In six weeks, she could not hear loud voice, and she remained locked up from external sounds, until to her surprise she heard the fork upon the vertex. The tubes opened readily, the membranes were a little opaque, but the tympana were apparently healthy. This seems to be an illustrative case of arrest of the labyrinthine inflammation from exhaustion of the irritation.

When the cause continues active, total deafness generally results, as in the case of a lusty blacksmith who applied to me for an opinion. He had suffered from proliferative inflammation of the tympana, with the usual symptoms of tinnitus, slight vertigo, and gradual loss of hearing. The membranes were like chamois skin, and adherent to the inner tympanic wall; the manubria were strongly retracted, so that they were nearly "end-on," and inflation caused no movement or sensation in the ears. There was total aural and cranial deafness. The man was and had been very healthy otherwise all his life. His history was clean, and no diathesis could be established.

When a patient has tympanic disease, it is not necessary to seek further for a cause of labyrinthine mischief unless very extraordinary symptoms ensue. When the history and symptoms lead to some one of the causes enumerated, it is rational to accept it, but one should bear in mind that several may be associated in the same case, as atheroma of vessels in gouty persons with heart disease; syphilis in those subjected to avocation-noises; and quinine poisoning in those who are habitually intemperate.

The causes in this first group generally excite the subacute form of inflammation of the labyrinth, which may be finally as damaging to the hearing as a more severe disease, but some of these causes may, also, start an acute inflammation or a destructive morbid process of great severity.

Another group of causes is more likely to excite acute inflammation, attended by effusion, exudation, hemorrhage, and grave pathological lesions. They are purulent inflammation of the tympanum; caries of the bony labyrinth, and fractures through its walls; violent concussions, severe cold, embolism, aneurism, apoplexia, parturition, syphilis, mumps, diphtheria, erysipelas,

measles, scarlatina, and variola; malarial, typhus and typhoid fevers; hydrocephalus, convulsions, meningitis, and cerebro-spinal meningitis.

In purulent inflammation of the tympanum, the membranes of the round and oval windows may be destroyed by ulceration or accidental puncture, and air and pus gain access to the labyrinth to cause inflammation. Caries and fracture of the bony labyrinth generally induce purulent disease in the cavity. Concussions from reports of firearms, blows, falls, etc., cause sudden deafness by paralysis of the nerve from shock, and by causing ecchymosis and hemorrhage in the labyrinth. Loss of taste and smell, and affections of the ocular muscles have been observed in this connection. Exposure to severe cold has caused sudden and grave decline of auditory power. In most cases, the disorder has been in the tympanum instead of the middle ear. Embolism of the internal auditory and of the basilar arteries has produced sudden deafness and atrophic changes in the labyrinth. Aneurism of the basilar artery, and intracranial tumors occasionally destroy hearing by pressure upon the auditory artery or nerve.

An apoplectic clot along the course of the auditory nerve or within the labyrinth has destroyed the hearing and the integrity of the membranous structures. Severe parturition is accompanied by congestion of the cerebral vessels, and may produce inflammation, effusion or hemorrhage in the labyrinth.

A patient during a rather severe bearing-down pain, felt or heard a loud snap in her right ear, and this was followed by loss of hearing, tinnitus, and vertigo. The labor terminated safely, the aural symptoms soon disappeared, and hearing gradually improved. Fifteen years later, I found Hw. $\frac{c}{80}$, and the fork was heard moderately. The membrana tympani was opaque and depressed, and other symptoms confirmed catarrhal otitis of long standing.

Syphilitic exudations, thickenings or gummata sometimes occur in the labyrinth and at the base of the brain, and damage the auditory apparatus. There is sometimes paralysis of the facial and chorda tympani nerves. I have a man under treatment, who has upon the right side a healthy tympanum and drum-head, open Eustachian tube, deafness, paralysis of the facial, chorda

tympani, and abducens nerves. My diagnosis is syphilitic gumma near the posterior border of the pons varolii.

Mumps is charged with setting up labyrinthine disease, though it oftener affects the tympanum. A lad came under my observation who had lost his hearing in one ear, from the disease. The membrane was opaque and everywhere adherent to the inner wall of the tympanum, inflation was nugatory, and the fork could not be heard when vibrating upon the mastoid or vertex. Perhaps the labyrinthine disease was secondary, and a consequence of that in the tympanum.

Diphtheria has in some instances been followed by total deafness, whether from labyrinthine disease or paralysis of the auditory nerve trunk, clinical experience has failed to establish. A treacherous poison that strikes down the proudest manhood by paralysis of the heart, would easily destroy the nervous power of the labyrinthine filaments.

The erythematous, malarial, and continued fevers, though more liable to affect the tympanum, sometimes cause great deafness, effusion, hemorrhage, and inflammation in the labyrinth. Many cases of labyrinthine disease following malarial fevers must be charged to the inordinate use of quinine.

Deafness occurs very frequently in typhus and typhoid fevers, but the hearing often returns with convalescence, which is proof that the loss of power has been occasioned by vitiation of the cerebro-spinal fluid and the peri- and endo-lymph, as well, as by the poisoned, torpid condition of the sensorium. Hydrocephalus affects the labyrinth by effusion into its cavities.

Children are liable to attacks of convulsions with rapid loss of hearing. Convulsions frequently produce effusion into the sub-arachnoid spaces and ventricles of the brain, and it is probable the labyrinth participates, since there is free communication of the sub-arachnoid spaces through the foramen acustica and aquæductus vestibuli, with the endo- and peri-lymph cavities. Primary inflammation occurs in the labyrinth, as several fully reported cases substantiate, and it is an open question, whether some convulsive attacks are not brought on by mischief therein. Meningitis is both cause and consequence of disease of the labyrinth. Purulent inflammation and probably milder diseases of the laby-

rinth excite meningitis and cerebral abscess, and meningitis frequently extends to the labyrinth and induces grave pathological changes.

Cerebro-spinal meningitis has become such a common disease, and it so frequently affects the internal ear, that abundant opportunity has been afforded to study the relations of the disease and its complications. Through routes already described, the inflammation of the meninges passes to the labyrinth and excites a morbid process, which advances rapidly, destroys the delicate apparatus, and causes total deafness at once; or it creeps on slowly, and makes its presence apparent during convalescence by slightly impaired hearing, then audition diminishes as the disease of the labyrinth progresses, until, perhaps, when the general health has been fully established, the patient is shut out from all worldly sounds forever. Sometimes certain tones can be heard, though the patient may be considered totally deaf. This indicates that a few terminal filaments of the auditory nerve have escaped destruction.

Disease of the tympanum, paralysis of nerves and muscles, and blindness are occasionally associated with cerebro-spinal and labyrinthine disease, and post-mortem examination has in some cases revealed purulent inflammation of the labyrinth and pia mater.

The symptoms of acute disease of the internal ear are generally very decided. There is sudden impairment of hearing in one or both ears, and this may be partial or complete; at the same time, hissing, whizzing, buzzing, rasping or thumping tinnitus, continuous or intermittent, comes on to distress the patient; he becomes giddy, objects seem to move about him in vertical or horizontal planes; he feels as if he were moving sideways, turning or falling, and may grasp things for support; he may walk unsteadily, whirl around, and, even, fall down. Great anxiety and fear of immediate death seize him; the face becomes pallid, cold, and moist; the pulse feeble, nausea is felt, and vomiting of the contents of the stomach and regurgitated bile frequently occurs. There may be spasm of the facial muscles, photophobia, oscillation of the eyeballs, diplopia from irregular action of the recti muscles, and dimness of vision on account of

dilated pupils. In rare cases, faintness and, even, unconsciousness ensue. Other symptoms may be present or some of these may be absent, but the clinical picture is unmistakable.

Ménière's Disease is a title that has been applied to this group of symptoms regardless of their cause. This is an improper application, because Ménière associated them with a definite pathology. The celebrated Frenchman advanced the following propositions, which I quote from Burnett:

"1. An auditory apparatus, hitherto perfectly normal, may become suddenly the seat of functional disturbances, consisting in noises of a variable nature, continuous or intermittent, and which may be accompanied, sooner or later, by a diminution in hearing.

"2. These functional troubles having their seat in the internal auditory apparatus, may give rise to symptoms which have been considered cerebral, such as intense vertigo, uncertainty of gait, turnings to the right or left, and falling, and they may be attended with nausea, vomiting, and syncope.

"3. These accidents, which are of intermittent type, are at last followed by deafness gradually growing worse, and often the hearing is at last suddenly and totally lost.

"4. All this tends to confirm the belief that the lesion, which is the cause of these functional troubles, is in the semicircular canals."

Burnett says: "Ménière's description of an aural disease contained in these four propositions is extremely comprehensive, but from the subsequent researches of many observers it cannot be applied to a solitary lesion in the semicircular canals."*

Ménière subsequently restricted the pathological lesion to the vestibule and semicircular canals, and Knapp believes it to consist in a serous exudative inflammation.

It is well known that the peculiar symptoms occasionally appear from irritation in the external auditory canal, various diseases of the tympanum, gastric disorders, and, rarely, from epileptic attacks and other cerebral diseases, without there being any

* The Ear, Its Anatomy, Physiology and Diseases. Burnett, p. 554.

lesion in the labyrinth. It may be stated in general that, when the group of symptoms mentioned is present in a patient, it should be considered an indication of irritation of the semicircular canals, not necessarily, but, perhaps, involving a pathological lesion.

The decline in hearing often makes the patient appear stupid; hallucinations of hearing occur sometimes, and the patient can hardly be convinced that the sensation has no external objective cause; a tone may be heard double, *i. e.*, as two tones in the same ear, several lines and spaces apart (*diplacosis monauricularis*), or one in each ear (*diplacosis binauricularis*); one or two peculiar sounds may be all that can be distinguished; the lower tones are often heard when the upper are lost; or the patient may be locked in eternal silence. A boy had slight inflammation of the tympanum from sea-bathing, and knocking a flat stone placed over his ear with another stone, in order to get rid of the water in the canal. He had paroxysms of pain the same night, during which he distinctly heard the knocking sounds repeated over and over again, exactly as he had heard them when he had used the stones. Recovery followed soon, but left imperfect hearing, though the cranial perception was fair.

The vertigo, tinnitus and loss of equilibrium may be great, but the mind remain perfectly clear and active. Again, temporary unconsciousness may rapidly follow the aural symptoms. Both conditions are seen in mild as well as in severe cases, and one cannot base a reliable prognosis upon either. The graver cases are occasionally associated with delirium and opisthotonos, generally, though not always, indicative of meningitis. The feeling which impels the patient to turn or fall varies much. If the right ear is affected he generally turns towards the left; if the left, towards the right.

Cyon says: "The semicircular canals are peripheral organs of the sense of space. The disturbances manifested after a lesion of the semicircular canals are due,

"(a.) To visual vertigo, produced by the discord between the space seen and the ideal space.

"(b.) To the false notions engendered as to the position of the body.

“(c.) To disorders in the distribution of the innervating force to the muscles.”

The immediate cause is variation in pressure of the labyrinthine fluid, whether induced by external forces or intralabyrinthine processes.

Longhi says: “The semicircular canals, on account of their great sensibility and of their contiguity to the cerebral centres, regulate the normal function of the muscular sense of the head, and in this way its equilibrium.”

When they are irritated or diseased, the equilibrium of the head and body is destroyed, the sense of space deranged, and the body is unstable. This instability is intensified when there is irregular action of the ocular muscles. The relation between the sense of space and the apparent space is disturbed in certain ocular affections, notably in astigmatism, and some persons with this anomaly suffer from vertigo and incoördination of muscles, though aural symptoms may be entirely absent.

The pathology of diseases of the internal ear has been well worked up by aural specialists.

Simple irritation induces hyperæmia and probably slight effusions, which disappear and leave the hearing about normal. Total inactivity of the conducting apparatus is said to cause atrophy of the auditory nerve. Light attacks of inflammation produce an infiltration of lymphoid corpuscles, described by Moos in caries of the bone and in affections of the tympanum during the continued and eruptive fevers.

Chronic inflammation causes thickening and atrophy of the membranous labyrinth, connective tissue development on the sacculus and utricle, stuffing of the cavities with a thick yellowish-white or soft reddish mass, deposits of corpora amylacea and lime crystals, decrease or increase of otoliths, the occurrence of calcification, ossification and hyperostosis, collections of pigment and cholesterine, diminution or increase of the endo-lymph sometimes changed into a hemorrhagic fluid or an opaque jelly-like substance, atrophy of the auditory nerve, and fatty degeneration of the organ of Corti.

Acute inflammation induces effusion, ecchymosis, hemorrhage, and purulent infiltration. Pus passes from the brain to the labyrinth and *vice versa*. Ecchymoses in the membranous labyrinth

have been found after continued fevers, variola, and acute tuberculosis. Hemorrhages have been noted after fracture of the bone, severe contusion of the skull, atheroma of the arteries, heart and kidney disease, acute tuberculosis, typhoid and typhus fevers, scarlatina, measles, mumps, gout, and syphilis.

Intracranial diseases destroy the integrity of the nerve. Atrophy of its fibres results secondarily from disease of the cerebellum, fourth ventricle, medulla oblongata, spinal cord, and from cerebral apoplexia, atrophy, softening, and hydrocephalus.

Tumors of various kinds occur in the labyrinth and upon and along the trunk of the auditory nerve. Tubercle, psammoma, neuroma, fibroma, sarcoma, and gumma are occasionally found pressing upon the nerve and invading its neurilemma either in the labyrinth or within the cranial cavity.

"In seventy-seven cases of tumor of the cerebellum, disturbances of hearing occurred seven times; in twenty-six cases of tumor of the pons, they occurred seven times; in twenty-seven cases of tumors of the middle lobes, three times; on the other hand, no disturbances of hearing occurred in twenty-seven cases of tumors of the anterior lobes, in fourteen of the posterior lobes, and in four of the fourth ventricle.

"Tumors of the cerebellum not infrequently produce bilateral total deafness, beginning first on the side corresponding to the tumor; and this bilateral deafness may occur even in cases where a direct pressure of the tumor on the nerve trunk of the second ear, or on its nucleus in the medulla oblongata, is utterly impossible, and where other symptoms of paralysis of other nerves of the brain or spinal cord on the second side are, also, wanting.

"Very continuous and laborious work is still needed in order to throw more light anatomically on cerebral deafness. After previous hardening of the brain, the whole region where the central ganglia lie from which the fibres of the acusticus arise must be successively dissected."*

Diagnosis of inflammation of the labyrinth and its complications is made from the history, the subjective and objective symptoms. In mild cases, the symptoms may leave one in doubt

* The Pathological Anatomy of the Ear. Schwartz, pp. 172-174.

whether there is anæmia, hyperæmia, slight effusion or moderate inflammation; the history will often aid materially in coming to a conclusion. Yet, functional disorders have symptoms so aggravated that the inexperienced are often misled.

The degree of deafness is a most important consideration; in general, the greater the diminution of hearing, the more certainty of grave disease. It should be remembered, however, that recoverable cases of deafness are encountered sometimes, though rarely, as results of hysteria, concussion, exposure to cold, mental exhaustion, anxiety, and general debility. The hearing *per vias naturales* will be partially, and, in severe cases, totally lost. A careful examination of the external canal, tympanum, and Eustachian tubes should be made in all cases. The sensations of the patient, when the tuning-fork is vibrating upon the vertex or mastoid, will show the degree of activity in the auditory nerve. In nerve deafness, the sound will not be increased by stopping the external meatus. In severe cases, the fork will not be heard at all, and a pistol-shot behind the patient will not attract any attention.

Brenner's formula should be compared with the aural reaction to the Galvanic current.

The nature of the vertigo and tinnitus should be studied; the defects of equilibrium carefully noted; the nausea and vomiting considered with reference to the condition of the stomach, and the cerebral functions examined critically. The cause is often as important as some of the symptoms in arriving at a conclusion, and so remote an organ as the heart or uterus may be the *fons et origo mali*. The early history throws a vivid light upon some cases. Only by a careful, scientific exclusion of some cerebral and other affections, and a calm survey of the important phenomena, can the lesion be located in the labyrinth or along the nerve trunk.

A stout, plethoric woman, 53 years of age, came to me for treatment. She had been doctored much by many physicians. She had progressive bilateral deafness, with loud tinnitus in the right ear, none in the left; she suffered from attacks of vertigo and nausea, occasional loss of equilibrium, and falling. She had taken much quinine, which had made her worse. No cachexia

was present, but I suspected syphilis. The right ear heard loud voice, left ear heard nothing. The right drum-head was depressed, opaque, non-adherent; the ear was easily inflated through its tube, and the tuning-fork was heard moderately well upon the mastoid, but not on the vertex. The left drum-head was opaque and partially adherent; inflation was impossible; the fork was not heard upon the vertex or mastoid. A diagnosis of chronic inflammation of both tympana and of the left labyrinth was easy, and the connection between the loss of equilibrium, the gastric symptoms, and the aural affection was much more evident than in most cases.

I saw a young lady, in 1875, in consultation with Dr. F. F. Rowland, of Media, Pa. She had had transient attacks of vertigo and staggering gait, with declining health for months. Amenorrhœa, nausea, vomiting, and great general debility were present. She had been treated for amenorrhœa and supposed gastric ulcer. Finally she took to her bed, the vomiting was frequent, the disturbance of equilibrium was great, but the mind continued clear. She had hyperæsthesia of the auditory nerves, could not bear noise, became distressed at some young ladies singing across the street, and had temporary attacks of diplopia.

I was impressed with the fact that the significant aural and ocular symptoms had not received the consideration they deserved, on account of the prominence of the gastric symptoms and the accompanying anæmia and amenorrhœa. Investigation revealed slight deafness and tinnitus, and a deviation of the axes of the eyes to the right side, and a study of the gastric phenomena convinced me that the frequent attacks of vomiting were of cerebral origin.

The lady had inherited a strumous constitution, and this in connection with the other phenomena led me to make a diagnosis of tuberculous tumor at the base of the brain. I suggested an ophthalmoscopic examination of the eyes, but never had an opportunity of making it, as my diagnosis was not accepted.

The post-mortem examination revealed a glioma the size of a pullet's egg, snugly ensconced in a depression in the base of the left lobe of the cerebellum.

The prognosis in inflammation of the internal ear and its complications should always be guarded. The lighter affections may

pass away, even, when the characteristic symptoms of Ménière have been violent. The prognosis is favorable, when deafness has resulted from hysteria, mental exhaustion, anxiety or general debility.

The effects of quinine, parturition strain, moderate concussion, exposure to cold, diphtheria, mumps, gout, and syphilis are not necessarily permanent, and scientific treatment may restore the labyrinth nearly to its wonted functional activity.

Nervous deafness from the eruptive and continued fevers frequently disappears under treatment, and the labyrinth returns to nearly a normal state.

When the inflammation is secondary to tympanic, cranial or visceral disease, the result will depend upon the success in treating the primary affection. Chronic proliferative and purulent inflammation of the tympanum, periostitis and hyperostosis of the temporal bone, atheroma of the vessels, and heart disease, are likely to cause permanent lesions.

The sudden occurrence of total deafness indicates effusion or hemorrhage in the labyrinth, or a grave cerebral apoplexia, and is of bad omen. Inflammation from fracture, caries, purulent infiltration, acute tuberculosis, peculiar convulsions, and simple and cerebro-spinal meningitis, are generally destructive of hearing, as well as dangerous to life. Lastly, when there is embolism, aneurism, cerebral tumor, apoplexia, hydrocephalus, cerebral mollities, in connection with great deafness and other aural symptoms, no just expectation of improvement in audition can be entertained.

Treatment.—The therapeutics of internal ear diseases will furnish the solidist and the humoral and neuro-pathologist with a limitless field for investigation and experiment. As in all other morbid affections of the body, it is more important to regulate the patient's diet and personal hygiene. The weak and anæmic must be well nourished and stimulated, the strong and plethoric dieted and depleted. Both should be protected from everything known to aggravate aural diseases, as cold, dampness, imprudent sea-bathing, continuous loud noises, excessive mental labor, excitement, anxiety, the inordinate use of tobacco and alcoholics, frequent child-bearing, residence in a malarial region, and taking large doses of quinine.

The sudden occurrence of Ménière's characteristic symptoms, without any demonstrable disease of the ear, may be regarded as functional, and treated with a small blister upon the mastoid, and the administration of Kali bromide, Conium, Amyl nitrate, Physostigma or Cinchona, according to the special indications.

The slowly progressive subacute inflammation of the internal ear from disease of the tympanum demands treatment of the latter condition, according to directions already given.

If the patient has a gouty diathesis, and periostitis of the temporal bone is suspected, nitrogenous food ought to be restricted, much out-of-door exercise taken, and Bryonia, Colchicum, Kali hydriod., Lycopodium, and Natrum salicylicum tried successively.

When quinine, menstruation, parturition, and other causes have brought on or increased labyrinthine congestion and deafness, Belladonna, Kali brom., Natrum brom., Acid. hydrobromic. will prove effective medicines.

Sudden deafness from exposure to severe cold and from concussion and convulsions should be treated at first by hot aural douches, and Aconite or Belladonna. After awhile, Kali hydriod., Strychnia sulph., and the Galvanic current may promote absorption and stimulate the nervous apparatus.

When the aural affection seems to be connected with disturbance of the circulation from heart disease, the patient should be kept quiet, and Aconite, Cactus grand., Digitalis, and Spigelia used *pro re nata*.

Disease of the labyrinth caused by embolism, syphilis, apoplexia or tumor requires the steady administration of palpable doses of Kali hydriod. and occasional intercurrent remedies. If syphilitic affection has been recent, Mercurius should be given in place of the former, which suits the latter stages better.

Aneurism can rarely be diagnosed as a cause of aural disease. I saw a case of suspected aneurism of the carotid at its junction with the circle of Willis. A squeaking sound synchronous with the pulse distressed the patient, and was heard by auscultating the temporal region. There were no other symptoms apparent. No treatment was advised, the sound gradually ceased, and the child grew and remained well some years, until I finally lost sight of him.

Roosa quotes Griesenger's symptoms of disease of the nerve from aneurism. They are: "difficulty in swallowing; occasionally spasmodic deglutition; impairment of hearing, or even complete deafness, often appearing at intervals, with great tinnitus; difficulty of respiration and articulation; interference with the excretion of urine; without any impairment of the intellectual functions; and finally paraplegia."

"Von Troltsch states that, a constant sensation of knocking in the back of the head is also a suspicious symptom."*

If the diagnosis were certain and relief imperative, compression of the carotid, or ligation of it or the vertebral artery might be performed with a prospect of cure. I should however be loth to recommend such a procedure. Arsenicum, Kali hydriod., Phosphorus, and some of the cardiac sedatives might be administered with some prospect of improvement.

When total deafness comes on suddenly without apparent cause, it is usually due to effusion or hemorrhage in the labyrinth, or to cerebral apoplexia. The latter will easily be recognized from the former by other than the aural symptoms depending upon the cerebral lesion. In either case, keep the patient's head elevated, permit no muscular movements, apply ice to the head and warmth to the feet, and give *Veratrum vir.* tincture in five-drop doses, every half hour, until the heart and pulse become a little weakened. This medicine is a powerful vascular depressant, and is not so dangerous as Aconite, because nausea and vomiting occur early to warn the physician when the limit of tolerance for it has been reached.

It is probable the aurist will not see these cases until the primary symptoms have passed, and the family physician consigns them to his care for special treatment of the ear. Then Kali hydriod. will promote absorption if any medicine will, and this may be aided by frequent applications of the Galvanic current. The results of treatment of hemorrhage in the labyrinth so far have not been brilliant.

When the internal ear is affected by tuberculous ulceration or deposition, little can be expected from local treatment, but the

* A Practical Treatise on the Diseases of the Ear. Roosa, p. 507.

general treatment by means of careful alimentation and the administration of *Ol. Morrhuæ* and *Calcareæ phos.* holds out the only hope of improvement.

Hydrocephalus causes a slow accumulation of fluid in the labyrinth and the sheath of the optic nerve, and deafness and blindness are sometimes late sequelæ of the disease. Anything that will diminish the intracranial dropsy will improve the aural condition. *Apis*, *Apocynum*, *Bryonia*, *Digitalis*, *Kali hydriod.*, *Mercurius*, and *Pilocarpin* will probably do all that any medicines can.

The torpor caused by the effusions or vitiations of typhoid and typhus fevers requires *Cinchona*, *Nux vomica*, and the Galvanic current.

Mumps, measles, scarlatina, erysipelas, and diphtheria cause disease of the labyrinth rarely, through a morbid process set up in the tympanum, though it is not unusual that the impulse comes from cerebral states accompanying the diseases. The middle ear if in a morbid state should be restored to as healthy a condition as possible. Any cerebral hyperæmia present must be reduced by cold applications to the head, and the administration of medicines. If the loss of hearing is sudden, use cold applications and *Veratrum viride* as already stated, when the constitutional disease does not prohibit them.

When the deafness and labyrinthine mischief have become stationary, after the systemic affection has terminated, *Mercurius*, *Kali hydriod.*, *Kali brom.*, *Cinchona*, *Strychnia sulph.*, and stimulation by the Galvanic current offer the most available means of relief. Electricity ought to have a trial when the nerve responds slightly to the tuning-fork, especially after an attack of diphtheria.

Primary inflammation of the labyrinth simulating meningitis, and secondary inflammation arising from meningitis, generally cause such destruction of the delicate apparatus of the labyrinth that little hope can be entertained of successful treatment. When not contraindicated, the early stage is best treated by cold applications and full doses of *Aconite*, *Belladonna* or *Kali brom.* After the acute disease has terminated and the patient is totally deaf, it would be rational practice to produce and maintain for

some time a suppurating sore upon the mastoid, and give Mercurius, Kali hydriod., Quinia sulph., Strychnia sulph., and applications of the Galvanic current a fair trial.

Charcot cured a case of this character by giving Quinia sulph., 15 grains three times a day for several months. The toxic effects of this powerful remedy must, however, be watched and the medicine stopped, if any symptoms of amaurosis supervene, since Dr. Grüning, of New York, reports a case in which eighty grains, administered in ten-grain doses, in a period of thirty hours, caused temporary blindness. Though good central vision was ultimately regained, the visual fields remained permanently contracted.

It would be better to give much smaller doses, than to risk so terrible a disaster as loss of sight, and it is altogether probable that two grains taken three times daily would do as much good as a more ponderable dose.

The effect of caries of the temporal bone has already been fully described, and no special treatment for labyrinthine lesion connected with it can do much good. The caries requires all our surgical skill and therapeutic resources, because it is not merely a question of danger of loss of hearing, but of death, if not immediately by shock or laceration, a little later, by reactive inflammation and great degeneration.

The pathognomonic signs of fracture of the temporal bone are, hemorrhage from the ear, a flow of serum, and paralysis of the facial nerve. Rupture of the round or oval membrane or a puncture through the outer labyrinth wall may, however, furnish the first two symptoms. The patient should be kept quiet with the head elevated, the external ear must be cleansed with water, a compress wet with dilute Arnica placed over the seat of injury, and Arnica given internally. When reaction and inflammation ensue, Aconite or Belladonna should be substituted for the Arnica, and the case treated according to general surgical principles.

Deaf-Mutism.—Consideration of the graver diseases of the auditory apparatus naturally leads to some account of that sad state of abolition of hearing denominated deaf-mutism. This term is not used in its strictest sense, but is understood to include cases in which the hearing is so defective, that the individual cannot distinguish articulate sounds well enough to understand

speech. Examination of the auditory power in many persons who are commonly regarded as deaf and dumb will prove a variable amount of hearing, some auditory nerves responding to one kind of noise and some to another, but the power of discriminating between words is always lost. Some of these afflicted ones can hear a few notes of the piano, the noise made by clapping the hands, the cracking of a whip, the rumbling of a carriage, railroad train or thunder; a loud shout in the ear, and the report of firearms. A shout in the ear or the report of a pistol near the head causes many deaf and dumb persons to shrink and express by their features some discomfort. Several that I have examined have complained that noise hurt their ears, though they presented no signs of disease to indicate hyperæsthesia. The auditory nerve, after it becomes incapable of distinguishing the quality of sound, still reacts in some degree to intensity.

Recent experiments with the dentaphone and audiphone teach one not to be rash in deciding, that there is inability to appreciate the quality of sound, until these new inventions have been tried; because there is no doubt, that some so-called deaf mutes by their use have been made to hear speech and enjoy vocal and instrumental music.

It requires examination by an expert to determine the condition of the auditory nerve, and though some sensibility may be revealed in many cases, there are others in which the hearing is totally abolished, and the patient lives in a realm as silent as the environs of the Sleeping Princess.

The voice of a person unable to hear himself speak is strangely modulated and harsh. Spoken language is regulated in pitch and rhythm, according to the sounds that the ear transmits to the consciousness. The hearing has an influence over speech analogous to that of sight over bodily movements. Deafness causes imperfect pronunciation, blindness irregular locomotion. When a person of mature age becomes gravely deaf, he retains his power of speech, but little by little the manner of speaking becomes altered, so that the voice is disagreeable to those with good hearing, though the patient is unconscious of the defect.

When young children lose their hearing for voice, they cease to progress in spoken language, soon forget their slender vocabu-

lary, and finally become in a certain sense mute. Older children with great deafness are liable to lose their knowledge of spoken language unless great care is taken by associates to keep them in systematic exercise of the vocal organs.

Loss of voice and abolition of the movements of the throat and chest organs in vocalization induce weakness of the pulmonary circulation, and general systemic disorders, which frequently lead to fatal disease of the lungs.

Congenital cases of deaf-mutism give utterance only to gibberish, unless they have passed through a long and laborious training in vocalization, whereby some intelligent students are enabled to use spoken language. The defects of this are, however, marked, and the importance of the hearing as a regulator of speech is made manifest. The vocal organs are in a normal condition in ninety-nine per cent. of deaf mutes, and only require proper exercise and training to acquire the power of speech.

Deaf-mutism is acquired or congenital. The records of asylums for the deaf and dumb show, that from forty to sixty per cent. of the inmates have lost their hearing through disease of the middle and internal ears.

From the history of many cases it becomes evident, that the sad results might have been prevented had proper treatment been applied during the progress of the aural disease.

More exact observation is constantly relegating cases that have been classed as congenital to the acquired group. The jelly-like mucus in the tympana of the new-born, the perturbations and exposures to which they are subject in the first months of life, and the difficulty of recognizing ear disease during this period, render it probable, that many infants acquire an aural lesion early, which when later discovered is considered congenital.

The congenital cases proper are those in which the auditory apparatus and associate parts are well developed, but the physiological action of which is impeded by some disease that has occurred during intra-uterine existence; and other cases, showing defective development, and absence of parts essential to audition.

The causes of deaf-mutism are, inflammation of the tympanum, disease of the labyrinth, intracranial disease affecting the

roots or trunk of the auditory nerve, and defective development of the auditory apparatus. The following pathological conditions have been found in cases of deaf-mutism: ceruminosis; thickened, depressed, adherent, shrivelled, perforated, and destroyed membrana tympani; adventitious bands, thickenings, granulations, tumors, and purulent products in the tympanum; ankylosis of the ossicles or absence of one or more of them; hyperostosis of the inner tympanic wall, and occlusion of the foramina; organic occlusion of the Eustachian tubes; cleft palate; caries and sclerosis of the temporal bone; fracture through the labyrinth; the vestibule full of morbid lymph, pus, caseous matter, blood, tubercle, and fibrin; increase in the quantity of otoliths; hyperostosis of the semicircular canals and cochlea; calcification of the lamina spiralis; the auditory nerve softened, hardened, degenerated, atrophied, and compressed by exostosis and tumors; and disease of the optic thalamus and posterior cerebral lobes.

Defective development is represented in this connection by the external canal stopping short in a *cul-de-sac*; the meatus entirely closed by bone; contraction and absence of one or more of the osseous semicircular canals; absence of the membranous semicircular canals; rudimentary state of the cochlea; absence of the whole labyrinth; and shortening and defect of the auditory nerve.

Diagnosis of deaf-mutism requires some care, and it is more difficult in children than in intelligent adults. Taken in a restricted sense, there should be inability to hear speech or to use it to express ideas. Some so-called deaf and dumb can hear words shouted into an ear trumpet, and express themselves in spoken language, if they have learned it before becoming deaf or have been educated in an asylum.

A degree of deafness in a child, that would not hinder an adult from hearing and using speech, will make the former speechless.

Parents or guardians present a child for examination, with or without a history of aural disease, and say, they believe he cannot hear, and they wonder why he does not learn to talk, or why he begins to mumble his words and speak indistinctly.

The auditory apparatus should be carefully examined and any

abnormalities noted. Seat the child and have its attention attracted in one direction by the attendant. Then shout aloud, clap the hands, blow a sharp whistle, ring a bell, and snap a cap upon a toy pistol behind the patient, taking care to prevent any commotion of the air from reaching him, and note the effect of these manœuvres. If he starts or looks around suddenly, it may be taken as evidence that some hearing exists; if not, he may be considered totally deaf.

An infant suffering from severe scarlatinal otitis was very restless, and did not respond to shouting and clapping the hands. I placed a vibrating tuning-fork of large size to one ear and then to the other, the child stopped its movements, "kept as still as a mouse," and a pleased expression swept over the countenance. I accepted these effects as conclusive that the sound was heard.

With older patients, an ear trumpet and dentaphone should be tried; the electrical formulæ compared; the tuning-fork made to vibrate upon the vertex and mastoid process, and questions asked and answered in writing or by speech if possible.

Mutes ought to be silent, but they often use meaningless sounds. Children that are totally deaf may utter aloud a few monosyllables, but no more importance should attach to this act, than to the speech of the educated mute. Neither can be accepted as evidence of hearing. Older persons who have learned to speak before their affliction, and those who have been educated in deaf and dumb institutions, will furnish a history of their disease and describe the symptoms accurately.

Treatment.—Any disease of the ear that is amenable to treatment should receive careful attention at the hands of the aurist, according to the principles presented in preceding pages. Every means of relief should be tried, not only to have all the chances of restoring or saving some hearing, but in certain cases to save the patient's life.

When the vowel sounds or words can be heard even faintly by artificial aid, the patient should be furnished with a conversation-tube, and the friends directed to exercise the patient's auditory apparatus daily by shouting into the instrument, and by encouraging him to repeat the sounds into the tube himself, in order to modulate the voice and retain speech, or learn it if necessary.

All attempts to use signs should be discouraged, and the voice should be exercised as much as possible. There is no doubt that the dormant power of some ears can be awakened in this manner to sonorous vibrations and both hearing and speech improved. Stimulation of muscles and nerves of a paralyzed limb will sometimes restore physiological action, and it is reasonable to suppose the same effects may be produced in the muscles and nerves of the ear by systematic and persistent efforts.

The audiphone should, also, be brought into use, because it is in just such cases that it has proved valuable. It has one advantage over the trumpet. Sound vibrations from it act upon the auditory nerve through the bones of the head, as in fishes, and thus it relieves the strain upon the tympanic muscles, which is very fatiguing. It would be rational to use it in connection with the ear trumpet. A training séance may in this way be continued longer than when only the trumpet is used.

When a patient cannot be made to hear the vowel sounds by means of a trumpet or audiphone, and it is evident that the auditory apparatus is greatly disorganized, or not properly developed, the parents should be informed that there is no hope of improving the hearing, and that measures should be taken to have the patient educated in an asylum.

It ought to be the province of the aural surgeon to advise the public in regard to methods of education of deaf mutes, but persons are not willing to accord him this right; they take the advice of the laity in preference to his, and often fail to send their wards to the best institution.

A deaf mute should possess a normal throat and vocal organs, a fair degree of intelligence, and good health, in order to master the details of the best system of education. The special training should commence not later than seven years of age, and about eight to ten years will be required to learn to speak, and to recognize what others are saying, by lip reading and observation of the act of vocalization.

There are three systems of educating deaf mutes :

1. Finger talking, or dactylology, and sense of sight.
2. Imitation of articulation, and lip reading.

3. Visible speech, or phonetic writing, and observation of the parts employed in speaking.

Dactylology is the system of communicating by signs; each letter of the alphabet is represented by a different position of the fingers, and by combining these, words are spelled rapidly.

This system was until recently the only one taught in England and the United States. Very few people understand the finger signs, and the mute is, therefore, unable to communicate with many persons except by writing, which is often inconvenient. The vocal organs remain inactive, and this predisposes to disease of the lungs.

Imitation and lip reading is a method of educating the deaf and dumb, which, though first originating in England, has been most extensively employed in Germany for many years. It is now taught to some extent in all European countries and in the United States, and is considered by those who have made the education of these unfortunates a study, as the best system extant.

Children are early taught by imitation and observation to employ spoken language, and to understand it by watching the movements of the lips of the speaker.

All artificial signs are forbidden, as tending to distract attention and hinder the progress of the student. Close attention, and cultivation of the inherent power of imitation in the child are requisite to success, and Dalby says, "The mute's alphabet is more correct and less arbitrary than our own."

The great advantage that one educated by this system possesses is, that he can go out into the world and understand what is said to him, while he is able to converse in language common to all.

Burnett affirms that "English mutes thus instructed have learned to talk not only their own language, but the French and German."*

Visible speech, or phonetic writing, and observation, advocated by Dr. Bell, consists in an amplification of the lip method, which the student is made to understand by drawings of the lips, tongue, palate, and larynx, in the various positions in which they must

* The Ear, Its Anatomy, Physiology and Diseases, p. 608.

be placed to utter vocal sounds. With this knowledge, comes the ability to recognize spoken language by observation of the face and throat, and the deaf mute is thus brought into communication with his fellow-men. It is thought by those qualified to judge, that this system is more easily taught and more capable of developing the vocal organs and the faculty of speech, than the German method. It is looked upon with favor in this country, and has already been adopted in several of our asylums.

Instruments to Assist the Hearing.—Nature is frequently assisted and improved by art. The practice of art, the mode of applying its principles, belongs properly to artists. Physicians are artists in many of their functions, but the public has not been educated sufficiently, yet, to accord them all their rights. The public suffers from this disregard, and assuming judgment upon things of which it is ignorant, unwittingly increases the physician's business.

Striking illustrations of these statements are furnished by the numerous patients, suffering from functional disturbances and organic diseases of the eyes, caused by improperly fitted spectacles, who are constantly applying to the oculist for relief.

Fitting spectacles involves so many nice questions in physiological optics, that neither the person most interested nor the so-called "scientific optician" ought to assume the responsibility of a decision.

I maintain that it is just as reprehensible, and almost as pernicious, for the deaf person or the shopkeeper to select an instrument to assist the hearing.

The auditory apparatus of mankind was not cast in a common mould, and no two cases of aural disease present the same characteristics. It is, therefore, necessary for the good of the patient, that the aurist should decide what instrument is best adapted to his case. The aural surgeon should find out by proper tests the amount of hearing power that remains after the resources of treatment have been exhausted. He should notice the length of the external auditory canal, its diameter at different depths, its curves and pockets, and the state of its dermic lining and glands. The two ears should be compared, the reaction of the auditory nerves to the tuning-fork noticed, and the probability of improvement

in one or the other ear from treatment considered. Instruments of proper dimensions should be selected and various shapes tried, in order to determine which one transmits sound the clearest and strongest.

The audiphone or dentaphone should then be adjusted and compared with the most efficient auricular instrument, and one or both ordered, according to the result of the examination and the finances of the patient. The educated aurist will readily appreciate the necessities of a given case, and I will present only a few points for consideration. The ear-piece of the ear trumpet should be smooth, fit the meatus closely, and not penetrate farther than the junction of the cartilage with the osseous canal. Preference should be given to small instruments, when they will enable the person to hear tolerably, as they are easier carried and manipulated. The instrument should be used alternately in each ear when feasible, in order that they may be stimulated by the concentrated vibrations, and be kept in as active a condition as possible. When one ear is affected by ceruminosis or purulent inflammation, the other should be used if possible, and treatment of the disease advised.

The audiphone or dentaphone should be tried in all cases where applicable. They are convenient instruments to manage, and the patient feels that his defect is not so apparent to the public with either, as when a trumpet is used. Their value for hearing general conversation and vocal and instrumental music has been frequently demonstrated. Vibrations are transmitted to the head best through the upper natural teeth, but with artificial upper teeth or the hardened gums, these instruments act tolerably well.

1. TOYNBEE'S ARTIFICIAL DRUM-HEAD consists of a disk of soft rubber about a centimeter in diameter, held between two small metal disks, which are fastened centrally at right angles to a small wire an inch long and terminating in a loop. The rubber disk is pushed in against the membrana tympani, its remains, the osseous ring or the ossicles, and the wire rests upon the lower wall of the canal within reach, so that the instrument can be withdrawn easily.

The patient can apply and remove this at pleasure, and he should keep the rubber and the canal scrupulously clean.

This appliance and the cornet had better be removed and left in a cup of water during the night, as constant use irritates the canal and often renders them unbearable.

The artificial membrana tympani is adapted to some cases of relaxed or contracted and depressed drum-head, perforation or destruction of it, and absence of one or more of the ossicles. It is an excellent protective of an exposed middle ear, occasionally favors reparation of the natural drum-head, and greatly improves the hearing.

FIG. 126.



G. TIEMANN & CO. N.Y.

CORNETS AND ARTIFICIAL DRUM-HEAD.

2. CORNETS.—These are little funnel-shaped instruments with oddly contorted mouths. The ear-piece is made to fit the external auditory canal, and the mouth rests in the concha against the auricle. They are made of silver to resist corrosion, and should be made to order to fit individual cases. The wearer can introduce and remove them easily, and this is fortunate because they require cleaning frequently. Cornets assist the hearing by keeping the meatus open and the canal straight. They are useful when the meatus is relaxed as in old age, the canal is unusually crooked or narrowed by malformation, cicatricial contraction, periosteal thickening or osseous growths.

FIG. 127.

G. TIEMANN & CO. N.Y.

ARTIFICIAL AURICLES.

3. ARTIFICIAL AURICLES are made of vulcanite or metal, in

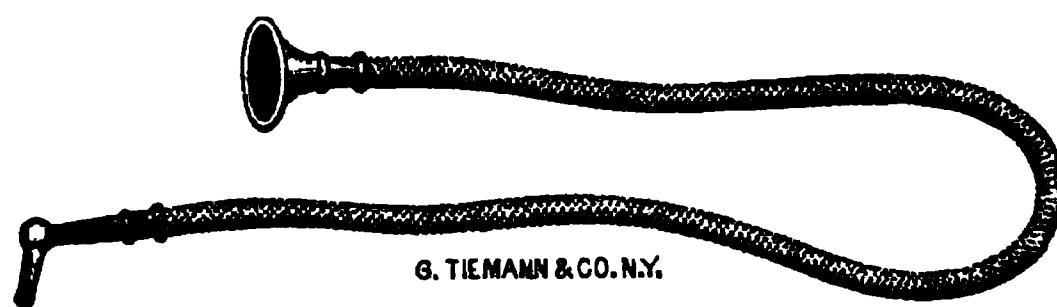
the shape of a whorl with one side flattened, and have an ear-piece projecting from the inside. They are made rights and lefts, one for each ear, and are united by an adjustable spring which passes over the crown of the head.

They fit closely to the anterior surface of the auricle, the mouth-piece is pointed forward and upward, and they can be easily concealed by ladies who dress their hair low in the old-fashioned way.

The instrument is very handy and useful for moderately deaf persons, who are obliged to hear and converse a great deal every day.

4. THE CONVERSATION TUBE is composed of an ear-piece to fit into the external canal, a mouth-piece of hard rubber, two inches in diameter, and a tube a yard long connecting these, made

FIG. 128.

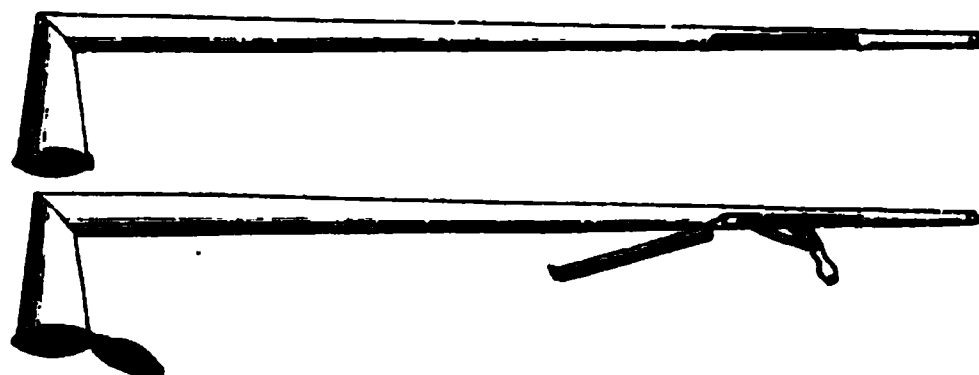


CONVERSATION TUBE.

of a spiral wire, covered with rubber, and overspun with silk. Sometimes the tube is made much longer, so that the mouth-piece can be passed around a circle and general conversation carried on without any one leaving his seat.

This instrument is much less clumsy than the trumpet, does not attract so much attention, and can be snugly stowed away in the pocket. It is an efficient aid to hearing a single voice close by, but does not transmit sound as well as a full flaring ear trumpet.

FIG. 129.



CANE.

5. EAR TRUMPETS are manufactured of many shapes and sizes.

They are made of tin, copper, and silver, and present smooth, firm, curved inner surfaces for the reflection and concentration of sound vibrations. The parts of a trumpet are the ear-piece,

FIG. 130.



CONE.

neck, and mouth. The ear-piece is only an inch or two long, makes a gentle curve with the longer neck, and terminates in a perforated knob. The neck is straight, slightly curved, or

FIG. 131.

HORN.

doubled upon itself, or it makes a complete oval, and increases in diameter towards the mouth. These departures from a direct line do not hinder the passage of vibrations. Sometimes the

FIG. 132.

BUGLE.

neck is beaded to the detriment of the instrument; sometimes it is made in sections to shut up like a telescope, and again it is elongated to serve as a walking-cane.

The mouth is made according to various patterns. In some instruments, it forms a slightly expanding handle for the cane-neck, and is fixed at right angles to it; in others, it consists of the prolonged neck, terminating in an obliquely cut lip; again,

FIG. 133.



TELESCOPE

there is a well-marked, bell-shaped end, continuing in a right line with the neck, or forming a curve more or less pronounced; and, lastly, it is made in the shape of a flaring cup, with the

FIG. 134.

TRUMPET.

mouth closed by a perforated plate, and the bottom like a parabolic curve to reflect sound vibrations into the end of the neck, which perforates the side and bends towards it.

FIG. 135:

DIPPER.

These different shapes are called the cane, the cone, the horn, the bugle, the telescope, the trumpet, and the dipper ear trumpets. They vary as much in power as in shape; the greater the

expansion of the mouth, and the larger the instrument, the better are vibrations of sound heard. The bugle is most agreeable for persons of delicate organization with rather sensitive ears. The horn is adapted to persons of coarser constitution and insensitive ears. The dipper is best for very deaf persons, who cannot hear well with the other kinds, and it is particularly valuable for use at concerts and public lectures.

Directions how to hold a trumpet would be superfluous.

FIG. 136.

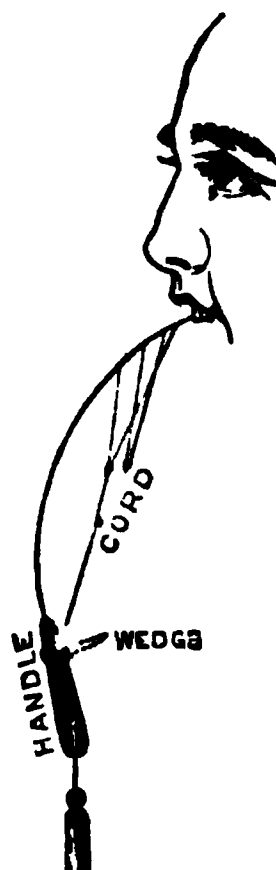
LONG DIPPER.

6. THE AUDIPHONE was invented by R. S. Rhodes, of Chicago, Ill., an able and honest publisher, who had been quite deaf for twenty years. He happened one day to place his watch between his teeth, and was surprised at the clearness with which he heard its ticking. He seized immediately upon the idea of constructing an instrument to assist the hearing by application to the teeth. His experiments led him finally to adopt and patent an instrument of vulcanite, shaped nearly like a quadrangle with rounded corners, and with a handle in the middle of the base, the whole having much the appearance of a fan. Four silk cords are fastened at the upper border, then united about half way towards the handle with a double cord, which is drawn tight and fastened under a wedge in the handle, so as to curve the fan towards the base. This constitutes the single audiphone.

A double instrument of the same general shape is now offered. It has two similar and parallel disks, with their bases united and inserted in the handle. The upper edges are notched and separated about a quarter of an inch by a row of beads. When in position, the voice of the holder vibrates between the disks and the sounds return intensified to the teeth. This makes the double audiphone more valuable than the single one as a means for the self-education of mutes.

When the audiphone is curved towards the base by drawing and securing the silk cords, it is taken by the handle, the convex surface turned outwards, the upper edge pressed firmly against the upper incisor or other teeth, and it is ready for use. Mr. Rhodes says: "Experience will regulate the exact tension needed

FIG. 137.



THE AUDIPHONE ADJUSTED.

for each person, and that necessary for different voices, music, distant speaking, etc. The audiphone is adjusted to suit sound, as an opera glass is focussed to suit distance." The vibrations which constitute sound impinge upon the convex disk, are transmitted to the teeth, the bones of the face, and base of the skull, and through these to the auditory nerve. When the Eustachian tubes are easily opened, some sound reaches the labyrinth through them. The audiphone is best adapted to cases of severe deafness, depending upon middle ear disease, in which the internal ear and auditory nerve are normal or nearly in a normal condition.

The audiphone does not attract so much attention as an ear trumpet, as many persons suppose it is a black fan, and when not in use it can be hung by a loop to a button inside the coat.

I have examined the evidence presented in favor of this invention, have read the reports of well-known and honorable business men, of physicians of prominence, of superintendents of asylums

for the deaf and dumb, and have made numerous experiments with my aural patients, and I consider it established beyond cavil, that the audiphone is a useful invention. It helps a certain class of deaf patients to hear, who by middle ear disease are shut out from ordinary sounds, and it deserves a trial by aural surgeons and others in every case of severe deafness.

THE DENTAPHONE is an instrument identical in principle and similar in shape to the audiphone. It is made of three thin sheets of vulcanite, which are united by brass hinges to form a nearly quadrangular-shaped fan with rounded top and corners, fixed firmly in a handle at the middle of the base. The hinged wings can be closed right and left, and the instrument can then be easily carried in the coat pocket. When the wings are unfolded, an elastic cord, connected with them upon the opposite side to the hinges, is drawn tight and slipped over a peg upon the handle to keep them open. There are no silk cords from the top of the disk to the handle to maintain a fixed curvature; this varies with the pressure against the upper teeth. The tension is not a fixed one, as in the audiphone with its cord fastened, and this is a disadvantage. The patient is liable to maintain improper tension, to vary it, and to twist and injure the instrument. Instruction and practice are necessary at first, in order to know how to hold the instrument.

There are two sizes of the instrument denominated the "Ordinary Conversational Dentaphone" and the "Lecture and Concert Dentaphone." The latter is larger and better for hearing lectures, concerts, and distant sounds; the former is well adapted for conversation and home use.

The vibrations of sound are collected by the dentaphone and transmitted through the bones of the face and base of the skull to the auditory nerve, as with the audiphone, and both inventions are adapted to the same class of cases.

The application of the dentaphone merits a few words. Unfold the dentaphone leaves, draw down the elastic cord and slip it over the knob upon the handle to keep them open. Hold the hinged side towards the face, place the upper edge of the disk firmly against the front of the canine teeth, or others near to their position if they are absent, and by upward pressure bend the fan

in an arc. Sometimes it is necessary to bend the disk to a half circle; the handle should always be held rather near the breast. The deafer the person, the greater should be the degree of curvature. Do not twist or strain the instrument; bend evenly and steadily, and keep the lips and lower teeth away from it.

FIG. 138.



THE DENTAPHONE.

When a person hears in the usual way through the external meatus, there is tension of the tympanic muscles of the ear; if there is disease in the tympanum, considerable voluntary power must be concentrated upon these muscles, and muscular fatigue will result.

It is not uncommon to find deaf persons, who hear readily when first addressed, but soon are unable to understand unless the voice is raised considerably. They are not able to maintain the muscular tension with which they first began, and relaxation ensues. This effort to hear is fatiguing, not only to the ear, but to the whole system, and patients show symptoms of debility. This is apparent in robust persons, but, of course, is much more noticeable in those whose general health is below par.

The use of a conversation tube or trumpet does not relieve the necessity for voluntary effort, but rather increases it, because they imply a degree of impairment of conduction in the middle ear, requiring more tension to overcome resistance, and greater nicety of adjustment to transmit the various tones. The volun-

tary effort is probably made with the trumpet in all cases, though the tympanic muscles be much hampered or even destroyed by disease.

The audiphone and dentaphone have the merit of relieving the patient from this voluntary effort, the muscular strain, and the consequent fatigue, by transmitting sound to the auditory nerve through rigid parts which cannot be accommodated.

The patient hears passively, as he sees at a distance without accommodating when his eyes are emmetropic. This superiority of the new inventions over the auricular instruments is so important, that they should have the preference whenever possible.

Dr. Knapp has made some comparative experiments with the dipper trumpet and audiphone upon very deaf persons. He asserts that the trumpet increases the hearing more than the audiphone, and gives the latter faint praise.* The duration of the improved hearing in each case ought to have been considered, because as trumpets do and osteophones do not cause aural fatigue, the duration of hearing by the former should be shorter than by the latter.

The different notes of a piano are generally heard readily by very deaf persons through the audiphone and dentaphone. The handle of the instrument may be rested at first upon a piano, and, as the patient becomes accustomed to the new sensation, he may withdraw farther and farther from the instrument.

A majority of those who know the sounds of spoken language distinguish words readily. Mutes and others, who do not know how words should sound, often hear them, but do not recognize them. Very deaf persons hear words imperfectly, and must learn to recognize them shorn of their labials and aspirates.

Regular systematic training is necessary to enable very deaf persons to understand with these instruments. It is advisable to have some one read aloud at first, while the listener is shown what words are being read. In this way he will soon learn to recognize spoken language.

Mutes with some degree of hearing can learn to speak by repeating, with the instrument against the teeth, the sounds of letters and words uttered by the teacher. A mute who has

* Archives of Otology, New York, 1880.

never heard has no idea of the meaning of sound words. He may be able to read and write, understand what is said by watching the speaker's lips, and, even, speak in the mechanical way taught in some asylums, yet, not be able to connect the sounds he utters or those he hears from others, with the printed characters which represent them in every language.

The audiphone or dentaphone will enable him to connect visible with articulate language, and persistent practice will rescue him from that unhappy band of persons, whose afflictions are regarded by some individuals as reproaches to our art, and by others as direct visitations of God.

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